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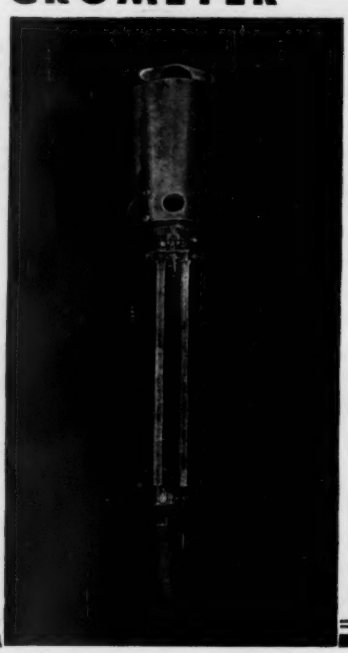

NATURE

No. 4450 SATURDAY, FEBRUARY 12, 1955 Vol. 175

CONTENTS

	Page
Co-operation and Development in South-east Asia	269
Physiology and Animal Production. By Prof. J. E. Nichols	270
Quantitative Genetics of Populations. By Dr. G. Pontecorvo	271
Biochemistry and Reproduction. By Dr. F. Lundquist	272
An Anthology of Anthropology. By Dr. E. Ashworth Underwood	273
Microwave Spectroscopy	273
Coal and Smokeless Fuels. By Sir Charles Ellis, F.R.S.	274
Powder Metallurgy. By Dr. I. Jenkins	276
Education and Training of Radio Engineers. By Prof. E. Williams	279
Obituaries :	
Sir Shanti Bhatnagar, O.B.E., F.R.S. By Sir Alfred Egerton, F.R.S.	280
Dr. G. F. C. Searle, F.R.S. By Prof. Frank Horton, F.R.S.	282
News and Views	283
The Biological Council : a Progress Report. By Dr. W. P. K. Findlay	287
Medical Research Laboratory of Vojvodina, Novi Sad, Yugoslavia. By Dr. P. Schwarz	288
The British Gelatine and Glue Research Association : Research Panel Meeting. By A. G. Ward	289
Statistics of Windfalls and Disasters. By David G. Kendall	290
Institute of High-speed Mechanics, Tôhoku University. By S. Weintroub	290
Sources of Germanium in Great Britain. By R. H. A. Crawley	291
Nitrifying Organisms in Glasshouse Soils. By Dr. R. Klein	292
Position and Reactivity of the Histidine Residues in Cytochrome *c*. By Dr. E. Margoliash	293
Letters to the Editors :	
The Sun's Magnetic Field and Corpuscular Emission.—Dr. Horace W. Babcock and Harold D. Babcock	296
Non-Linear Plasma Oscillations and Bursts of Solar Radio Emission.—S. F. Smerd	297
Disintegration Scheme of Copper-62 and its Relation to Recent Mass Measurements.—J. M. Reid and I. F. Wright	298
Thermal Diffusion Potentials and the Soret Effect.—Dr. J. N. Agar and W. G. Breck	298
Fission of Peptide Bonds by Lithium Borohydride.—J. C. Crawhall and D. F. Elliott	299
Protein Synthesis in the Cell Nucleus.—Prof. Daniel Mazia and Dr. David M. Prescott	300
A New Reagent for the Histochemical and Chemical Detection of Calcium.—S. M. McGee-Russell	301
An Intracellular Lipoidal Cycle and its Disruption by Neutral Red.—Dennis Lacy	302
Lipid Nomenclature.—H. H. Hutt	303
Flowing Chromatography on a Circular Paper Pack.—Prof. K. V. Giri and D. B. Parihar	304
Relative Contribution of Disparity and Convergence to Stereoscopic Vision.—A. A. Rady	305
Functional Structure of the Retinal Fovea and Maxwell's Spot.—Kosaku Isobe and Prof. Koiti Motokawa	306
Grouped Variations in the Occurrence of New Protein Components in Normal Human Serum.—Dr. O Smithies	307
Long-Term Transplants of Infantile Rat Pituitaries cultivated *in vitro* and grafted in the Anterior Eye Chamber of Young Cats.—Petar N. Martinovitch and Dushanka V. Radivojevitch	308
Paratyphoid-A Phage Typing.—Prof. D. D. Banker	309
Nature of the Pigment of *Aplysia depilans*.—Prof. A. Christomanos	310
Peculiar Stratified Shape of Typhoon Waves.—Fr. E. Gherzi, S.J.	310

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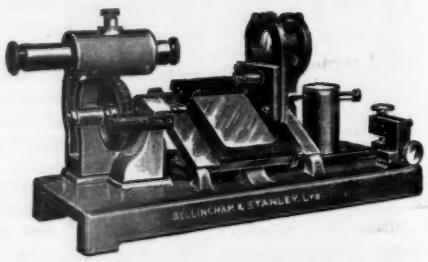

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CO-OPERATION AND DEVELOPMENT IN SOUTH-EAST ASIA

IN the debate on December 3 in the House of Commons dealing with Colonial development and related matters, there were some interesting references to the progress of the Colombo Plan for the economic advancement of South-East Asian countries. The information given on that occasion is amplified by the report for 1953–54 by the Council for Technical Co-operation in South and South-East Asia* and by the third annual report of the Consultative Committee on Economic Development in South and South-East Asia, which has since been published†. The former shows clearly how technical co-operation has widened its scope. Not only are all countries of the area participants in the scheme and, except Thailand, the Philippines and Laos, full members of the Council, but also technical co-operation has become more closely related to capital aid and to actual needs and priorities established by the Asian countries in their national development plans. There is now a tendency towards operations involving all three forms of technical co-operation—experts, trainees and equipment—along with capital aid, and disconnected operations are replaced by co-ordinated and continuous operations with one project serving as a link in the chain of planned development.

With these two trends has been an approach to a better balance between the training of the countries' nationals at home and abroad. The flow of trainees abroad has not diminished; but it is now apt to be concentrated on higher training. Mutual technical co-operation among the countries of the area has also developed, and the report cites examples of the exchange of experts and the offer of training facilities in institutes or on development projects to countries about to embark on similar projects. The expansion of technical assistance has also made more urgent the need for co-operation among the numerous agencies working in this field.

Up to June 30, 1954, about £2 million had been expended under the Scheme against appropriations of £8 million, and a further £2 million was committed. This compares with more than £1,000 million already spent on economic development programmes; but the report points out that it is not easy to assess the impact of technical assistance. Such co-operation is usually applied at strategic points of the economy, and often the expert is a catalyst of the whole economy. Nevertheless, there seems to be little doubt as to the real contribution which most of the individual technical aid projects have made to the national economic development plans, though the report fully recognizes that there is always room for improvement.

Among the current difficulties on which some stress is laid are the determination of priorities and the timing of projects. There are also difficulties in the selection of trainees and of equipment, and in finding the right expert for the job. Posts of professors at universities and technical institutes are hard to fill, for example, and it is difficult to recruit some types of engineers and technicians. There is an increasing demand for experts to undertake executive responsibilities as well as offer technical advice. It is suggested that more use could be made of firms of consultants, and that better use could be made of the equipment provided if it could be associated with the work of experts in the field, or of trained men returning from studies abroad.

These difficulties are fully appreciated in the report on the Colombo Plan as a whole which the Consultative Committee has issued since its meeting at Ottawa in October, at which Thailand, Japan and the Philippines were admitted as full members of the Plan. The chapter of that report which deals with technical assistance does not indeed go into such detail; but it sets its progress against the broad background of the other technical co-operation schemes operating in the area, under which nearly 5,000 places in all have been provided for technical training and some 2,500 experts and technicians have been sent to put their skill at the service of the countries concerned. Even so, the progress of the Technical Assistance Programme, which manifestly is increasingly appreciated by the Asian members, stands out, with the increase of 27 per cent in total development expenditures throughout the area—a figure expected to increase by 31 per cent in the current year—as perhaps the two most satisfactory features of the report.

The full impact of the development programme, like that of the Technical Assistance Programme, will not be felt for some time, in view of the long-term character of many of the projects. Indeed, the value of the technical assistance programme cannot be measured adequately either in monetary or statistical terms; but it has clearly played a vital part in the economic progress recorded in this report, and the Technical Co-operation Bureau which has been established at Colombo during the past year, in accordance with a recommendation at the New Delhi meeting in October 1953, to establish direct channels of correspondence with information units of member countries, to collate and distribute information and to constitute a central pool of information in the Colombo Plan, should undoubtedly facilitate that process. Meanwhile, without under-rating the magnitude of what still remains to be done, it can be said that the decision to embark on far-reaching and comprehensive programmes of economic development was both courageous and right.

Co-operation between the member countries is now taken for granted, and while the financial problems of the Colombo Plan countries, relative to the needs of development, are most serious and the gap between estimated costs of development programmes and

* The Colombo Plan. Technical Co-operation Scheme. Colombo. July 1954. (London: H.M.S.O., 1954.) 1s. net.

† The Colombo Plan. Ottawa, October 1954. Cmd. 9336. (London: H.M.S.O., 1954.) 4s. net.

foreseeable available financial resources is widening rather than narrowing, the growing extent to which resources have been mobilized for development outside conventional financial mechanisms is encouraging. The Asian countries are aware that the main burden must be borne on their own resources, though external aid can smooth and accelerate progress towards a higher standard of living. They are aware, too, of the difficulties that attend planning within a framework of democracy, and for some of them the problems of development are rendered infinitely more complex by political and economic instability and the scarcity of trained administrators and technicians.

Despite these problems, the future of the Plan appears promising now that its members are conscious of a great and growing partnership, animated by a common purpose and increasing awareness of each other's problems and aspirations. That future is all the more promising in view of the prospects of American economic aid to this area. The Colombo Plan has, it should be recognized, gone some way to create the conditions in which such additional money can be effectively used. The primary need for technical aid is being met, and some steps have been taken to hammer out a well-balanced and intelligently applied economic programme which can counteract inflation. Evidence of maturity is growing; but this is a slow process and care will be required if the new American proposals are not to tempt the backward countries to take on huge programmes of development with their own overtaxed—and often corrupt and inefficient—administrations.

Perhaps even more important, no new offer or programme should promise conditions which will disturb the understanding and partnership which have already been established under the Colombo Plan. Neither ideology nor propaganda has anything to contribute towards the solution of the acute problems of economic development in South and South-East Asia, and either could easily hinder progress. That needs to be remembered as much by the critics of the British Government's proposals for Colonial development and welfare as by the Administration in Washington, where the future size and scope of American economic and technical aid to Asia is at present being debated.

Last November, Mr. Harold Stassen, director of the Foreign Operations Administration, suggested that, while Western Europe is no longer in need of American economic aid, the time is ripe for a massive effort to aid the economic development of the free nations of Asia. He had already denied that his Government, which attended the Ottawa meeting as a full member for the first time, would use the Colombo Plan as its main instrument for channelling economic aid into Asia. The Technical Aid (Point Four) Scheme, bilateral military and defence support agreements and the World Bank will continue to be the main agencies for American aid; and, while this new American initiative should be welcomed by all the Colombo Plan countries, much more thought is required as to the way in which the American contribution can best be given. If, for example, the financial contribution is on the scale that material needs alone would require, the balance and the unique relationships of the Colombo Plan could easily be upset and distrust and resistance aroused by vested interests.

While any such generous gesture from the United States deserves to be warmly welcomed, and although the financial needs of the under-developed countries are still great and scarcely diminished as yet by the Colombo Plan and other agencies, much joint study is yet required before the manner in which American resources can best be made available can be determined. It is in this context that Britain's plans for Colonial welfare and development need to be considered. Her contribution to the Colombo Plan and to the Technical Assistance Programme of the United Nations is not one of which she needs to be ashamed, and it is only a small part of the contribution made from her limited resources to world welfare. Apart altogether, however, from such questions as the tempo of development, the order of priorities, and the magnitude of the resources we can afford to allocate for overseas development, Britain has both a great responsibility and a unique opportunity for leadership in evolving the appropriate forms of co-operation and the safeguards against any attempts to use such schemes for ideological purposes. If that opportunity is to be used, however, and that responsibility faithfully discharged, Colonial welfare and development cannot continue to be made the plaything of party politics. Both major political parties must bring to the task the magnanimity, the vision and the statesmanship without which no financial generosity is likely to achieve its purpose of securing a fuller economic development of the under-developed countries and a clearer understanding and closer co-operation between them and the Western world.

PHYSIOLOGY AND ANIMAL PRODUCTION

Progress in the Physiology of Farm Animals

Edited by Dr. John Hammond. Volume 1. Pp. vii + 392. (London: Butterworths Scientific Publications, 1954.) 45*s*. net.

In recent years the lack of either an adequate textbook or a comprehensive reference book recording the marked advances in the scientific study of animal production has been seriously felt by all whose interests lie in this field. On one hand, as Dr. John Hammond rightly points out in his preface to this volume, "present day medical and veterinary textbooks cover too narrow a field"; on the other, scientific contributions range widely and tend each to be highly specialized; they are reported in such a multiplicity of publications that even research workers find increasing difficulty in familiarizing themselves with progress in their own sector and much more in the field as a whole. But, quite apart from the needs of advanced students, research workers and teachers, there has developed a marked awareness on the parts of farmers and stockmen engaged in animal husbandry that successful practice

must depend upon a sound foundation of applied physiological knowledge.

No one person can be said to have changed the attitude of the practitioner to his work and problems more than Dr. Hammond, whose own research and influence have contributed so greatly to the development of scientific animal production. It is therefore of considerable interest to notice his appreciation of the general needs, as marked by the topics into which he has segregated the general scope of recent scientific advances, and by the collaborators he has chosen to review them in the series of volumes of which this is the first to appear under his editorship.

Clearly, progress in physiological studies has not been made on an even front, so that some variation in content, authority and scientific and practical significance of the different sections is only to be expected, particularly when the contributors have, wisely, been allowed a good deal of freedom of approach to their own particular interests. Even so, it must be pointed out at once that this volume suffers from inconsistent proof-reading and inadequacies of expression as between various sections, together with some overlapping of matter; these minor blemishes can easily be overcome in future editions and in the further volumes of the series.

Two main segments of the general field are covered here: nutrition and metabolism, and environment. Many considerations must obviously affect the sequence of contributions in such a compilation, but the present reviewer's preference would have been to give the latter some priority of appearance, not because of the nature of the contributions or their significance, but simply because the complex of ecological factors affecting animal production is that which the animal husbandman, and the scientist, are least able to control, yet largely decides the broad patterns of production as found in practice.

In reviewing ruminant nutrition, K. L. Blaxter properly orients the discussion by starting with aspects of rumen development with age, and then proceeding to a useful, critical and thoroughly up-to-date treatment of the parts played by the rumen flora in carbohydrate and protein metabolism. Following this, R. Braude presents an equally thoroughly documented and comprehensive review on the nutritional requirements of the pig, which may well rank as one of the outstanding contributions to the literature of farm animal physiology for many years to come; in any event, it is valuable at the present time, and has an additional merit for advanced students in frankly indicating the gaps and weaknesses of current information in relation to practical conditions of pig management.

In marked contrast to these, W. Bolton has relied very largely on already available reviews of the field of poultry nutrition, and has sought, instead of bringing their matter up to date, to make a formal treatment of his topic possibly more appropriate to a text-book concerned particularly with biochemical aspects. Only eleven authors are directly quoted. What, however, is taken to be the main conception of the whole volume is regained in D. P. Cuthbertson's section, which provides a most useful statement of the trace element situation in its broadest relations with animal production; particular care has been taken in the discussion of those complex cases where deficiency or excess of more than one element is involved.

About half the present volume is devoted to environmental considerations, to which N. C. Wright's comprehensive examination of work on the ecology of domesticated animals forms a most appropriate introduction. Breadth and precision of treatment are here most successfully attuned to yield another notable contribution to the literature, enhanced by the author's clarity of expression and the fact that this section is conspicuously free from proof errors. Its value is such that it prompts a criticism—that from the wealth of his familiarity with this field the author might well have thrown out ideas regarding the techniques of study and on other ecological factors that await analysis.

J. D. Findlay and W. K. Beakley, active participators in research on the environmental physiology of farm animals, give a critical review of experimental work, in which they do not hesitate to suggest its practical implications or to point out the needs for further investigations, as, for example, on the neuro-endocrine systems. Their main concern is with the thermal environment and heat regulation in mammals, but J. C. D. Hutchinson in his review of heat regulation in birds has found it necessary to refer to man and to repeat some of their material in attempting to give a reasonable orientation to his, especially since he enlarges his task to include discussion of the role of birds in food production, particularly in the now under-developed agricultural regions.

The final section is contributed by N. T. M. Yeates, who has brought together old and new information on the influence of daylight changes on reproductive and other physiological processes, almost at times with special pleading to establish its fundamental significance in practical animal production.

Dr. Hammond earns not only the congratulations but also the grateful thanks of all those whose needs he has so well sounded, for placing in their hands what must be regarded as an indispensable reference for this and a considerable future time.

J. E. Nichols

QUANTITATIVE GENETICS OF POPULATIONS

Symposium on Genetics of Population Structure held at Istituto di Genetica, Universitá di Pavia, Italy, August 20–23, 1953

Edited by Adriano A. Buzzati-Traverso. (Union Internationale des Sciences Biologiques. Série B—No. 15.) Pp. 141. (Naples: Secrétariat général de l'U.I.S.B., 1954. Distributed by Libreria Internazionale Garzanti, Palazzo Universitario, Pavia, Italy.) 2.30 dollars.

THE twenty participants to this symposium included all the foremost authorities on the subject, with the exception of Sewall Wright. The aim was to ensure an exchange of views on those aspects of quantitative inheritance which are most relevant to the genetics of populations. For this reason there were few papers; most of the time was available for discussions. Unfortunately, these have not been published. Besides six papers, the Proceedings of the Symposium contain short comments by Dobzhansky, Lerner and Epling, the conclusions by Buzzati-Traverso and the scholarly but delightful address of thanks by Haldane. These glimpses are certainly enough to whet the appetite of the reader and to make him the more regretful that the discussions have not been published in full.

As to the six papers, Clayton, Morris and Robertson gave a summary of a long-term programme, still in progress, of selection for high and low numbers of abdominal bristles in *Drosophila*. (It is a mystery why these authors, and most other geneticists, persist in calling the bristles 'chetae', instead of 'setae'.) One of the interesting results after five generations of selection is the great variation between replicates of the same selection experiment, as if initial sampling accidents were quite important.

A paper by Falconer dealt with the asymmetrical response in mice to selection for high and low weight and high and low milk yield. In both experiments there was a more rapid response downwards than upwards. The author suggests that this asymmetrical response would be expected in cases in which either or both "unequal initial gene frequencies" and "directional dominance" occur. These two terms are defined precisely.

Scossiroli reported on the results of selection for bristle number in *Drosophila* populations after heavy X-ray irradiations. The starting populations used had been selected already for twenty-seven generations prior to irradiation, and further selection was no longer capable of producing further inheritable change. After X-irradiation there occurred a new spectacular response to selection in the 'high' direction but not in the 'low' one. It seems to the reviewer that the main interest of this work lies precisely in this difference. It could be that X-ray-induced inheritable variation is mainly in the direction opposite to that for which natural selection had to work harder—a point well worth investigating at the threshold of the atomic age. The canalization of developmental systems may be such that any one of them is more liable to upset one way than the other. The genes picked up by natural selection in the past history of the species would buffer asymmetrically: either there would be more acting against the direction of more likely disruption, or they would be more effective. Destructive mutations are therefore more likely to act one way. Artificial selection after irradiation will be more effective than before irradiation one way, but less effective the opposite way. Contrary to the first impression which might be gathered, this experiment suggests that irradiation is likely to increase the rate of change, but only in the direction opposite to that of natural selection.

Wallace reported on 'coadaptation' of the various linear arrangements of the third chromosome in wild populations of *Drosophila pseudoobscura*. This paper contains such a wealth of valuable information that it is not possible to summarize it here. It certainly convinced the reviewer that there is a tendency for pairs of chromosome sequences within one population to be reciprocally adapted in the sense of conferring increased fitness to the structural heterozygotes.

A paper by Clausen considered the dynamic balance between variations or fluctuations in the environment and potential or expressed variation in populations. One by Harland Lewis reported on chromosomal variation in the *Clarkia* genus. He concluded in favour of causal relations between additional chromosomes and colonization of new habitats.

The summing up by Buzzati-Traverso, and the comments by Dobzhansky and Lerner, clearly showed how far the classic theoretical framework of population genetics has led, and how necessary it is that the change in outlook already in progress should go on and be put to test. This change in outlook is essentially a shift of emphasis from the single gene to the integrated systems of chromosomes, the genotypes of the individuals and the whole gene pool of populations. For this change in outlook the theoretical tools—statistical, ecological and developmental—are still lagging behind. G. Pontecorvo

BIOCHEMISTRY AND REPRODUCTION

The Biochemistry of Semen

By Dr. T. Mann. (Methuen's Monographs on Biochemical Subjects.) Pp. xiv + 240 + 7 plates. (London: Methuen and Co., Ltd.; New York: John Wiley and Sons, Inc., 1954.) 16*s*. net.

THE increasing use of artificial insemination in animal husbandry, and even to some degree in human medicine, is based to a considerable extent on knowledge of the metabolism of spermatozoa, their nutritional requirements and the physical conditions necessary to secure prolonged life outside the organism. This body of knowledge has hitherto been widely scattered in publications, many of which are not readily accessible. It is therefore with great satisfaction that one welcomes a monograph on this rapidly expanding subject, written by a man of science who, together with a number of co-workers, has made outstanding contributions to our knowledge of the composition and metabolism of semen. Dr. T. Mann's book is the first comprehensive exposition of the biochemical facts and problems relating to reproduction in mammals as well as lower forms (including even an occasional paragraph about plants).

The biochemistry of semen may appear at first glance to be a very special field without much interest outside the rather narrow group of specialists actually engaged in research on seminal biochemistry; but in fact this book should appeal to a much wider public, including not only veterinary officers interested in artificial insemination and clinicians studying problems of human fertility, but also the general biochemist who through reading it will realize that the biochemical mechanisms operating in the elaboration of the numerous components of seminal fluid present many absorbing problems. The general biochemist may also find that spermatozoa offer many advantages as a material for the study of intermediary metabolism in the intact cell, because they are easily obtained uncontaminated by other cell types, and their physiological activity manifests itself through easily observable movement.

The difficulties which are inevitable when an attempt is made to review so heterogeneous a field have been solved in a very satisfactory way. The introductory chapter gives a kind of cross-section of the book, surveying in a clear and sufficient manner the anatomy of spermatozoa and of the accessory sex glands, and gives a description in chemical and physiological terms of the various secretions contributing to the seminal fluid. In the following two chapters is found a thorough and critical discussion of such topics as the physical and chemical criteria used for assessing the quality of semen, the freezing of sperm, spermicidal agents and the use of various diluents for spermatozoa.

The second half of the book is devoted to a more detailed treatment of the impressive array of specific substances found in spermatozoa and seminal plasma. Among these substances may be mentioned fructose, which in most species so far studied constitutes the

main nutrient for the sperm cells, inositol and citrate, found in large amounts in some animals, ergothioneine, various choline compounds and a number of enzymes. This scholarly discussion of many fundamental biological problems should prove of considerable interest also to biochemists and physiologists working in other fields.

The historical background for the development of seminal biochemistry is by no means neglected; some readers may even hold that too much space is devoted to historical matters. In my opinion, however, this historical note is important in a book which will undoubtedly become the standard text in the field, and certainly contributes greatly to make pleasant reading. The illustrations are on the whole very well chosen, but a number of structural formulæ of simple substances (one of which contains two misprints) might well be omitted. The list of about one thousand references, though not complete, will be found very useful, and so will the subject index. Author, editors and publishers are to be congratulated upon the production of this excellent monograph.

F. LUNDQUIST

AN ANTHOLOGY OF ANTHROPOLOGY

Primitive Heritage

An Anthropological Anthology. Edited, with an Introduction, by Margaret Mead and Nicolas Calas. Pp. xxx+592. (London: Victor Gollancz, Ltd., 1954.) 21*s*. net.

IN a brief introduction to this book, Margaret Mead refers to the change in the type of anthropological literature which has developed in the past half-century. The armchair school of collectors of tales and legends was succeeded by the comparative school, which has become more and more dependent for its material on first-hand accounts of the life of individual tribes. In the text itself there is an essay by Ruth Benedict, published in 1932, in which the same attitude is taken. The reader who picks up this book for the first time might therefore expect a marked bias towards writings emanating from the psychological or psychoanalytical school of anthropologists. Any such fears may be discounted. The collaboration between the anthropologist and Nicolas Calas, the distinguished art critic, has produced an extraordinarily interesting anthology which will serve its purpose—to leave the reader often unsatisfied and in the mood to ask for more.

The fairness of the selection can readily be seen by a glance at the contents. The work contains one hundred and eleven extracts, and of these only about seventy date from the present century. The beginnings of the anecdotal school are represented by Herodotus, Tacitus and Strabo. The various parts of the work deal with such fundamental happenings or activities as childbirth, puberty, marriage, war, sport, death and immortality. Even those who have read much of the material in its original form will find renewed pleasure in reading straight through the book, as the reviewer has done. The extracts are very well chosen. There are some surprising omissions; but the compilers would no doubt justify them. Frazer and Westermarck find no place in the book, and it may be suggested that Tylor has just succeeded in gaining a place. Malinowski is well represented, as also are Sapir, Fortune and Ratcliffe-Brown. Hermann Melville gets in twice. The modern reporter of an international football match might read with profit Catlin's description of the ball game among the Choktaw, written more than a century ago. From the literary aspect one of the finest extracts in the book is written not by a professional writer or by an anthropologist, but by an artist—Maya Deren's passage from "Divine Horsemen".

In addition to its extensive use as a bedside-book—which is quite probable—this anthology may well be recommended to the student of anthropology as a rapid introduction to the great literature of the subject. In its next edition the compilers should certainly provide it with an index.

E. ASHWORTH UNDERWOOD

MICROWAVE SPECTROSCOPY

Microwave Spectroscopy

By Prof. Walter Gordy, Prof. William V. Smith and Prof. Ralph F. Trambarulo. (Structure of Matter Series.) Pp. xii+446. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1953.) 64*s*. net.

MICROWAVE spectroscopy is a comparatively new branch of physics which has arisen out of the development of radar techniques during the Second World War. Already, however, significant contributions have been made to the fields of molecular and solid-state physics. This book, by Profs. W. Gordy, W. V. Smith and R. F. Trambarulo, attempts to survey and to summarize the information which has so recently been accumulated. Thus, it cannot be regarded as a text-book, although many research students will find it a useful and concise introduction to the techniques and results of this branch of spectroscopy. The major part of the book is devoted to topics concerned with the spectroscopy of gases; and although this is perhaps not unexpected in view of the contributions to this field from Prof. Gordy, nevertheless it does present rather a biased account when, of the three hundred and fifty pages available, only fifty are allocated to the discussion of the microwave investigations of the solid state.

After an introductory chapter on the techniques and design of microwave spectroscopes, there are three chapters summarizing the measurements on gases, one chapter on the microwave spectra of solids and liquids, and four later chapters devoted to nuclear properties, more detailed discussions of molecular structure and possible applications of the microwave experiments in other fields. The book is well written, admirably presented, and there seem to be very few printing errors. There are a large number of helpful diagrams and a valuable collection of references. The appendix contains an impressive amount of data in tabular form.

The book will undoubtedly appeal to the research worker wishing to refer to an up-to-date review of a rapidly expanding branch of physics. A book of this nature, however, suffers from a serious liability, since, in order to maintain its appeal, new editions must be available as the subject advances. In Britain the published price is 64*s*., and this is scarcely a price which can commend the book to scientific workers anticipating a later edition; many students may decide that the expense of the present edition makes ownership of the book a considerable luxury.

COAL AND SMOKELESS FUELS*

By Sir CHARLES ELLIS, F.R.S.

THE term 'solid smokeless fuel', as applied to domestic consumption in Britain, embraces the requirements of four classes of appliance: (*a*) boilers and closed stoves; (*b*) openable stoves; (*c*) modern gas-ignition open fires; and (*d*) ordinary open fires.

For boilers and closed stoves, anthracite and hard coke from coke ovens are excellent fuels, and 'Phurnacite', a manufactured fuel, is prepared specifically for this use. All these fuels can also be used on openable stoves if these are carefully regulated. A more reactive coke, such as gas coke, however, is really more suitable, and this type of fuel can also be used in modern open fires with their deep beds. These fires are, of course, even better served by the highly reactive specially carbonized fuels, such as 'Coalite' or 'Rexco', which can indeed be burnt quite satisfactorily on the ordinary open fire.

Any new type of smokeless fuel can conveniently be described in terms of this classification by stating for which appliances it is eminently or reasonably suitable.

It will be obvious that boilers and openable stoves are already fairly well catered for, and it is the provision of smokeless fuel for the open fire that presents the really difficult problem, for two reasons: first, there are a great number of ordinary open fires; and secondly, any smokeless fuel that is to replace coal must be as reactive; that is, as free-burning, as coal.

Coke, either hard coke or gas coke, will play an important part in any programme for the provision of smokeless fuel. Unfortunately, only some of the coals found in Britain are coking coals; for example, it is impossible to make lump fuel directly in this way from powdered dry steam coal. First of all it has to be mixed with pitch, and the resultant sticky mass pressed into the form of briquettes. These briquettes have little strength, and would be very smoky if they were burnt because of the pitch they contain. To give them the requisite strength, and also to get rid of the pitch, they are carbonized in a heated oven. These are the essentials of the 'Phurnacite' process for making use of this finely divided coal.

It must be emphasized that among the manufactured smokeless fuels already on the market, 'Coalite', gas coke, and oven coke are all made from carbonization coals, that is, coals which when heated to drive off the volatile matter become plastic and form a coherent coke. If, then, the supply of smokeless fuels for the domestic market is to be increased, the question immediately arises whether this should be by processing more and more carbonization coals. From the purely technical point of view, such a policy could be implemented straight away by putting up more plants along existing lines; but the vital factor in determining the National Coal Board's research policy has been an appreciation of the long-term supply position of carbonization coals.

In the year 1952 the total production of coals of the types customarily regarded as suitable for carbonization was 97 million tons, while the actual consumption of coal by the coke and gas industries was 53 million tons. At first sight, therefore, it would appear that there would be no difficulty at all in meeting the demands of these industries for coal. In fact, however, the comparison ignores at least two important considerations. First of all, a large tonnage of coking and gas coal (36 million tons in 1952) was too high in ash content or in sulphur content to meet the rather exacting specifications of the carbonizing industries. From the balance of coal that is suitable in quality must now be subtracted the large coal, the total production of which is barely sufficient to satisfy demand (chiefly from the railways and the domestic coal market). The result of all this is that, far from there being a surplus of carbonization coal of these types, there is actually a deficit, which amounted in 1952 to 8 million tons. This deficit is made good by the distribution to the gas industry of coal that in former days would have been regarded as too low in rank to be suitable for gas manufacture because the make of good coke was unsatisfactory. The tonnage of lower-rank coal taken by the gas industry has been increasing steadily for many years.

Difficult as the position now is, it will not become any easier, because, speaking generally, British output in future will contain more of the lower-rank coals, which are easier to get than many of the higher-rank carbonization coals. The coal requirements of the carbonizing industries are, on the other hand, expanding every year, both in terms of actual tonnage and in proportion to the total consumption of coal. This is shown quite simply by the comparative figures for 1939 and 1952: in the former year the tonnage of coal supplied to the coke and gas industries was slightly more than 39 million tons, or 21·4 per cent of the total home consumption, whereas in 1952 it had risen to 53 million tons, or 26 per cent of the total.

The realities of the situation make it imperative that any extension in the production of smokeless fuels should not make the supply position more difficult by utilizing high-rank carbonizing coals; new developments should depend on the comparatively low-rank general purpose coals.

This was the situation that led the National Coal Board to decide that it must have some process by which it could manufacture smokeless domestic fuels from coals which would always be in ample supply; any new process must, moreover, use as its starting material fines or powdered coal, and not large coal or sized coal for which, generally speaking, demand is already in excess of supply.

The two things to be done are, first, to agglomerate small or powdered coal into sizes and shapes chosen to suit their subsequent use, and secondly, to make this agglomeration smokeless.

One further point must be made in order to explain the attitude of the National Coal Board to the problem. The Board intends to develop a range of smokeless fuels that will be specialized to their individual purposes and will be premium fuels. Though the urgency of the situation is clear, it would be wrong to be led into panic measures to deal with it. To supply the necessary quantity of smokeless

* Substance of a Friday Evening Discourse at the Royal Institution on December 10.

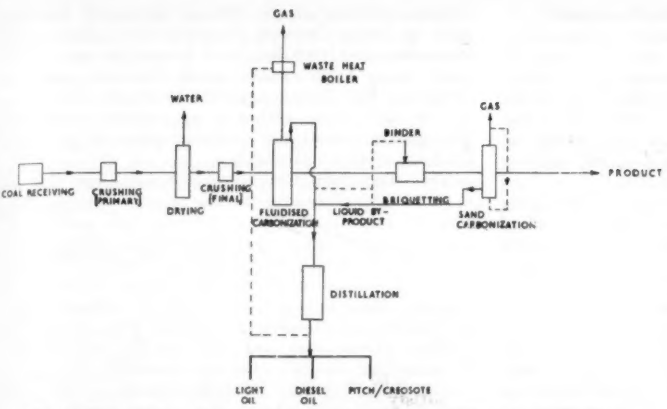

Fig. 1. General flow diagram of combined process of fluidized devolatilization, briquetting and carbonization

fuel in one way or another may possibly involve the country in spending more than £200 million in building plants that may have a life of forty years. To spend all this money on plant to produce smokeless fuel that is perhaps just good enough, but which no one really likes, would be ruinous. The aim must be to build for the future and to develop new processes that will represent a real technological advance, based on the acquisition of new knowledge.

The Board's Research Establishment at Stoke Orchard has for the past two years been focusing all its efforts on this problem, and from the beginning one thing was clear: if the fuel was to be smokeless, it meant that a large amount of volatile matter had to be extracted; but the economic success of the operation would depend very largely on the extraction of that volatile matter in a useful and saleable form. A series of operations on the coal, in contrast to the simple single process of the coke oven, was also envisaged; but if this were to be economically feasible, it would be essential to use the efficient methods of modern chemical engineering. For these reasons, almost from the beginning it was decided to treat the coal in a fluidized state.

The fluidizing process is now well known and is common practice in many industries. If air or some other gas is driven upwards through a column of fine granular material such as sand or coal-dust, it is possible so to adjust the flow that the individual particles are practically airborne, and the mass as a whole has the mobility normally associated with a fluid. The material has an average density corresponding to the degree of aeration, and objects will float or sink in it just as if it were a true fluid. If either hot inert gas or superheated steam is used as the fluidizing medium, then not only can the coal be moved from vessel to vessel like a fluid, but also it can be heated at the same time.

Probably the most important advantage of this new approach is that it provides a better way of extracting volatile matter. The hot stream of fluidized gas acting on each of the separate small particles extracts the volatile constituents much more quickly, and as a result they are not broken down to anything like the same extent as in high-temperature carbonization in a coke oven, or indeed in some of the conventional low-temperature methods.

The fine char that has been devolatilized in this fluidized process is a difficult material to compact and briquette, and a number of ways of doing this are under investigation. The most promising involves the use of a binder, and since this binder, like the

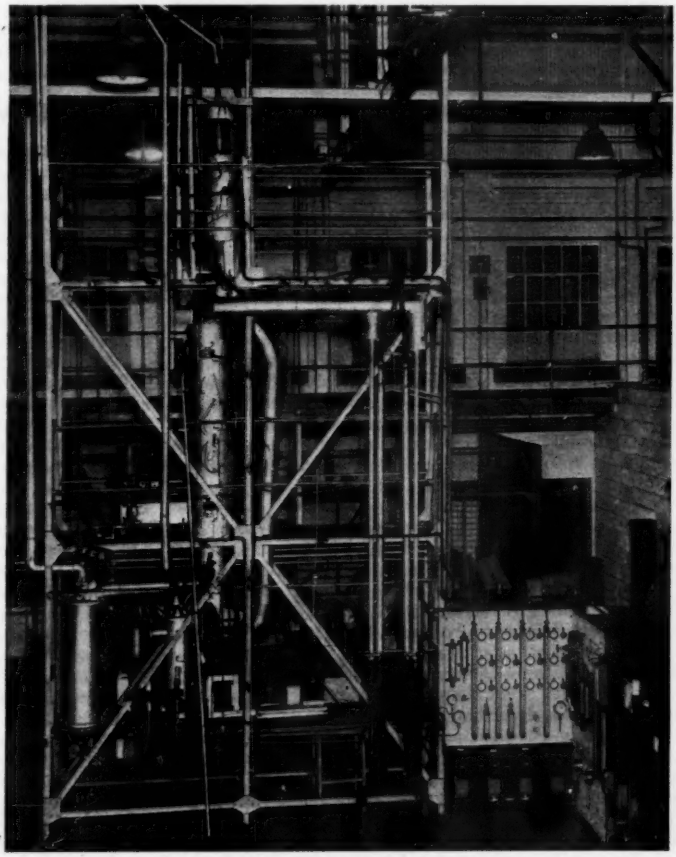

Fig. 2. Experimental plant for combined devolatilization, briquetting and carbonization at Stoke Orchard

pitch used in the manufacture of 'Phurnacite', is smoke-producing, a second carbonization is necessary. Such multiplication of stages could not, of course, be contemplated using batch-wise operation with equipment composed of a large number of individual units, as in a coke-oven or 'Phurnacite' plant. This has been avoided in the first heating stage by using the fluidized method; but obviously another method has to be sought for treating the briquettes.

This major difficulty has been overcome by using a method of hot-sand carbonization. In this method the briquettes move through a single large vertical vessel much like a continuous vertical gas retort; but the essential new feature is that they are heated up to carbonizing point by a stream of red-hot sand that flows continuously around and past them.

The advantages of this new method of carbonization are great. First of all, it gives much more rapid carbonization, and therefore lower capital costs per ton carbonized per year. Secondly, it is a continuous process and gets away from the bogey of batch operation.

Fig. 1 shows the general flow diagram of the combined process of fluidized devolatilization, briquetting and final carbonization.

Finely divided coal goes into the large carbonizing vessel, from which come off the gas and liquid products. While still hot, the char is airborne into the briquetting stage, where it is mixed with pitch tar derived mainly from the second carbonization, but with some make-up from the first carbonization. The briquetting is carried out at a high temperature, and with the least possible loss of heat the briquettes go into the sand carbonizer.

Although it is impossible at this stage to give precise figures for the yields of the various products from the combined process, it seems likely that for every 1,000 tons of coal going in there would be produced about 660 tons of a clean uniform briquette with about 15 per cent of volatile matter. This fuel would be smokeless but would light with paper, and would give a bright, cheerful fire.

In addition to this solid fuel, there would probably be about 1,000 gallons of light oil, 4,000 gallons of diesel oil, and 15,000 gallons of pitch/creosote boiler fuel. The gas would practically all be used in supplying heat for the process; it is also an attractive feature that the plant would produce its own binder. It may be said, therefore, that the coal is carefully taken apart and reconstituted into two forms, uniform briquettes of controlled volatile matter and a liquid fuel.

There is still, of course, a long way to go before the process is in commercial operation. Its feasibility has, however, been established in experimental plant on a 50 lb./hr. scale, and good progress is already being made on the next stage, which is forty times larger—that is, one ton an hour. After that, the process will have to be carried to the pilot development stage of, say, 20–40 tons an hour through-put. Fig. 2 shows the 50 lb./hr. plant at Stoke Orchard.

In parallel with the development of the combined process just described, some further work at Stoke Orchard has been concerned with the ever-recurring difficulty that, in order to make smokeless lump fuel from the small coal of the really abundant reserves, it is necessary to go to all the trouble of putting in something sticky to hold the coal together, and then carbonize this to form a firm cement. The pitch that is frequently used is not only expensive, but also half its value is lost when it is carbonized.

Quite recently at the Board's Research Establishment at Stoke Orchard there has been discovered a simple method by which hard briquettes can be made from these high-volatile coals without using any binder at all. The briquettes made by this method can be carbonized, either in an ordinary oven or by the new process of sand carbonization, to give a final product of great strength.

This discovery has great potentialities and may revolutionize thinking on the whole subject of supplies to consumers, for if by a simple method it is possible to re-form coal from fine dust without having to fall back on the rather clumsy expedient of adding pitch, a considerable step has been made towards meeting the shortage of lump coal. The Board can face with equanimity a greater and greater production of fine coal, and can turn this into sized coal of whatever size the market demands.

The fact that this method provides a very simple way of making a strong coke of any reasonable size from a non-coking coal may be of great help in the future in removing anxiety concerning the reserves of the precious carbonizing coals.

In conclusion, it must be emphasized that all these developments are still only in the research stage. Difficulties and disappointments will be met, and the pattern of demand may have changed somewhat in a few years time; but even if the exact application of this new discovery cannot be foreseen, it seems certain that it constitutes a significant advance.

POWDER METALLURGY

POWDER metallurgy is an ancient art but a comparatively new science in spite of the fact that, for fifty years or more, metals of high melting point, such as tungsten, have been manufactured in massive form by the sintering of the metal powder. The development some thirty years ago of sintered metal carbides, initially for machine tools, opened up a field which rapidly assumed considerable importance in the engineering industries, and which has steadily expanded both in scope and in the nature of the sintered material. It was not until the Second World War, however, that powder metallurgy began to assume increasing importance for the manufacture of general engineering components and of alloys to precise composition and property specifications. In 1949 a symposium held in London directed attention to the ever-broadening scope of the industry and of the trends in its development.

The considerable progress which has been made, both in the science and practice of powder metallurgy, during the intervening years was clearly demonstrated at the second British Symposium held in London during December 1 and 2, under the auspices of the Iron and Steel Institute, in association with the Institute of Metals. A significant expansion in the manufacture of metal powders and in the diversity of components produced from them has been coupled with developments in manufacturing equipment and techniques, while both pure and applied research work has led to a better understanding of the basic principles on which the industry is founded.

A total of fifty papers was presented at the symposium, of which approximately 25 per cent were submitted from overseas. They were discussed in four half-day sessions under the following headings:

Group I: Manufacture, Properties and Testing of Powders; Group II: Principles and Control of Compacting and Sintering; Group III: Manufacture and Properties of Structural Engineering Components; Group IV: Powder Metallurgy of High-Melting-Point Materials.

The considerable interest in powder metallurgy was reflected in the attendance at the meeting, which attracted more than five hundred delegates, of whom approximately ninety came from overseas.

Manufacture, Properties and Testing of Powders

Developments during recent years in the manufacture of metal powders have been aimed primarily at reducing the cost, while improving the control and quality of the product. A significant trend is towards methods in which the powder is the direct end-product of the process of extraction of a metal from its ore, rather than in the disintegration and comminution of metal in bulk. The gaseous reduction of metal oxides, the reduction of iron oxide by an iron powder of high carbon content, electrolytic processes and the reduction of metal salts in solution by hydrogen at elevated temperatures and pressures are processes of increasing importance in this connexion. The manufacture of powders of ferrous and non-ferrous alloys by atomization is one of the most important developments in powder manufacture during recent years, particularly in view of its scope and comparative low cost.

The hydrogen reduction process has, for many years, been used in the manufacture of iron and iron alloy powders for magnetic purposes, particularly in the telecommunications industry. The control of the physical properties of the alloy powders so produced leads to a wide range of applications.

The physical properties of a metal powder, including the shape, density, surface condition and size distribution of the powder particles, have received special study in recent years, and considerable advances have been made in methods of examining these properties. The behaviour of brittle, tough and ductile metals on mechanical grinding leads to the interesting conclusion that, with soft metals, an equilibrium particle-size is reached irrespective of the initial particle-size used. While the control of quality of metal powders has undoubtedly improved as a result of investigations such as the above, there is still considerable scope for further study and for improvement, particularly when it is realized that surface films and absorbed gases can in themselves significantly affect the compacting and sintering properties of a metal powder.

Tantalum lamp filaments were made from the sintered metal at the beginning of the present century; recently this metal, together with zirconium and titanium, has assumed growing industrial importance. While arc-melting techniques are being developed for the latter two metals, tantalum, on the other hand, is likely to remain a product of powder metallurgy. Its extraction as a powder on a commercial scale, involving sodium or calcium reduction processes, is an interesting example of the scope of modern chemical engineering. Where titanium or zirconium is required in powder form, the metal sponge is embrittled with pure hydrogen and then ground. The absorbed hydrogen may be removed by sintering the compacted powder *in vacuo*.

Principles and Control of Compacting and Sintering

Excepting when liquid phases are present during sintering, sintered materials are porous. In certain cases, porosity may be deliberately encouraged, as in the manufacture of permeable bodies for filters, cooling units, porous bearings, etc.; for general engineering components, where the best mechanical properties are required, porosity is undesirable. One technique which has been developed to reduce this effect is to 'infiltrate' a permeable sintered metal skeleton with a molten metal of lower melting point.

Research work in the powder metallurgy field in recent years has paid particular attention to porosity in sintered components, either with the view of developing a theory of sintering; to control permeability where such a property is required; to note the effect of porosity on mechanical properties; or to study the process of infiltration. The mechanism of infiltration is similar to that of sintering in the presence of a liquid phase, where the primary property determining the processes involved is that of the free energy of the interface between the solid and liquid phases. The transference of the solid phase by a solution in the liquid phase determines the final structural condition obtained, which, in turn, will have a bearing on the mechanical properties of the component.

While the effects of re-crystallization and grain-growth on the progress of solid-phase sintering are clearly established, the mechanism of closure of isolated pores is still a matter of conjecture. Studies, however, of sintering in the presence of an active atmosphere, such as a halogen, which results in improved mechanical strength and ductility in sintered metals and a rounding off of pores, open up a new field of considerable scope. The use of a flux, either solid, liquid or gaseous, in order to ensure that true interparticle bonding is achieved during sintering is likely to enhance considerably the importance of powder metallurgy in the manufacture of general engineering components.

Studies of the nature in which uniform and non-uniform powder particles pack together are providing basic information on the properties of permeable sintered bodies. Perhaps, however, the most intriguing development work on the compacting of metal powders is that of the production of sheet or strip direct by the rolling of powder. Considerable success has already been achieved on an experimental scale with this technique, in which the compacted powder strip is eventually sintered to a density very close to that theoretically possible. This process, particularly if it can be coupled with sources of cheap metal powders, holds out considerable promise for the production of metal strip at very low cost.

The influence of the physical properties of metal powders on the mechanical properties of sintered compacts produced from them is not yet completely understood, although much information is being accumulated on this particular aspect. The difficulty, of course, is that there are so many properties of a metal powder particle which may have a bearing on the properties of the ultimate sintered component. Over and above this, the sintering atmosphere itself can play a most important part, and the choice of sintering conditions—either a controlled atmosphere or a vacuum—can, when everything else is under control, markedly influence the physical and mechanical properties of a sintered compact.

Manufacture and Properties of Structural Engineering Components

Various methods are employed in the manufacture of sintered metals for general engineering applications in order to reduce the porosity of sintered metal parts. In general, sintered components show satisfactory mechanical strength but low ductility. In recent years many investigations have been made of the effect of re-pressing and re-sintering on the strength and ductility of a wide variety of sintered metals and alloys. Re-pressing and re-sintering increase the strength and ductility of sintered components, and it is reasonable to assume that this is achieved by improvement of the intergranular bond-strength by the breakdown of films, either solid or gaseous, which inhibit true bonding. Re-treatments of this kind, however, are expensive and, undoubtedly, the use of a gaseous flux to ensure true bonding and hence satisfactory mechanical properties after one sintering operation only will figure prominently in future research work. Investigations of this kind, undoubtedly, will also be related to improvements in the intergranular bond-strength in permeable bodies for turbine components, in which permeability plus high strength is required for parts which are maintained at a safe working temperature by means of a cooling medium such as air. The use of pre-alloyed stainless steel alloy powders for permeable components such as filters is now well established; but, up until now, such components have not met the strength requirements necessary for turbine components which are stressed in service.

Permeable bodies have been used for some considerable time as oil-impregnated bearings; recent developments include the 'oilless' bearing materials, which consist of a porous metallic matrix impregnated with 'Fluon'. The 'Fluon' is introduced into the porous skeleton either by hot pressing or via aqueous suspension, from which it is then sintered into the pores of the matrix. Bearing materials of this kind run dry in corrosive conditions and permit the use of high surface speed when a liquid coolant is present at the bearing surface.

Copper–lead bearings have been produced for many years by casting the alloy on to a steel backing. This process is difficult to control, and the quality of the bearing material leaves much to be desired. It is now possible to produce bearings of this type by a process in which the copper–lead is sintered on to a copper-plated steel strip, which can then be rolled to dimensional requirements and given a final sintering treatment. High-quality bearings are produced in this way, and a study of the manufacturing process has contributed much useful information on the mechanism of sintering in the presence of a liquid phase.

An important development in the powder metallurgy of light metals has been that of sintered aluminium containing a high but controlled percentage of aluminium oxide (about 13 per cent). The presence of the oxide results in creep and fatigue properties, at temperatures up to 400° C., superior to those of the best precipitation-hardened aluminium alloys. Furthermore, the room temperature properties of the material remain unaffected after prolonged treatment at temperatures as high as 550° C. Recent investigations have been concerned with the application of this principle to alloys of aluminium, and they show considerable promise. Similar principles are being applied to the production of material of high-tensile strength from magnesium powder. There is undoubted scope in the powder metallurgy of light metals, including perhaps titanium, for techniques similar to that developed for sintered aluminium.

Powder metallurgy is now being used for the manufacture of alloys to precise composition limits in order to ensure close control over a particular property which may be sensitive to slight changes in the basic composition and to the presence of trace impurities. In the electrical industry, certain alloys for sealing to glass are being made by powder metallurgy methods and the sintered alloy fabricated into strip or wire according to requirements. Magnetic alloys of high permeability and low loss, based on nickel, are also being made by sintering followed by processing into strip. There is undoubted scope, particularly in the electrical industry, for alloys made in this way to precise composition limits.

Powder Metallurgy of High-Melting-Point Materials

With the development of the gas turbine and the demand by the engineer for materials to withstand ever higher temperatures and stresses, it is of particular interest to note that one of the earliest groups of sintered products, namely, sintered carbides, is figuring very prominently in development work in this field. Interest in this connexion centres mainly around titanium carbide for a number of reasons, including the fact that it is of relatively low density and has an encouraging strength at temperatures up to 1,000° C. However, the resistance to oxidation of this material bonded with cobalt does not meet requirements; although the addition of other carbides, such as chromium, niobium, vanadium and tantalum, improve both the creep strength and the resistance to oxidation. The high-temperature properties of these materials are determined largely by the properties of the matrix or bonding material, although it is considered that the primary carbide phase does influence the strength of the matrix. In this connexion, investigations into alternative bonding materials, such as heat-resisting alloys, indicate that creep strengths superior to those of the alloys themselves can be obtained. However, the low impregnated strength and cold ductility, plus the difficulty of fabrication, are at present severe limitations on the accepted use of these materials for gas turbine components.

In recent years considerable interest has been shown in alternative intermetallic compounds having high temperature stability, including silicides and borides of the transition metals. Considerable investigations have been made in recent years on mixed metal–silicide systems. Many of these compounds show exceptional resistance to oxidation at temperatures of 1,500° C. or more, and recent studies have shown that this is due to formation of a protective oxide layer rich in silica. Much further development work, however, will be required before compounds such as silicides are accepted for engineering applications, primarily because of their extreme brittleness and the ease with which they react with metals considered for bonding them.

The possibility of manufacturing certain of the existing high-temperature alloys by powder metallurgy methods have been investigated. These materials in the right condition normally depend upon complex carbides for the development of satisfactory high-temperature creep-fatigue resist-

ance. The introduction of carbides in the necessary concentration in the equivalent sintered alloy presents difficulties, due to reaction between the carbon and the oxide present in the metal powders used. The possible solution here may be the use of alternative precipitates to carbides for the development of satisfactory high-temperature strength.

Metal – ceramic mixtures are a comparatively new field for research and development of materials for high-temperature service. Metal-bonded alumina compounds figure quite prominently in the investigations which have so far been carried out. Satisfactory bonding between the metal and ceramic is essential for strength at high temperatures, and basic studies of the wetting of ceramics with metals form an important part of research work in this field. As in the case of titanium carbides, the work has shown that a thin layer of bond metal has much greater strength than that of the bond metal in massive form, and this is attributed to the inability of the thin layer of metal to deform plastically. Increasing information is becoming available on the high-temperature properties of ceramics bonded with metals. The optimum composition would appear to be in the neighbourhood of about 50 per cent by weight of the metal. The interesting point of view has been expressed that for optimum properties and, in particular, good resistance to thermal shock, the metal network and the ceramic network should both be continuous. I. JENKINS

EDUCATION AND TRAINING OF RADIO ENGINEERS

THE present demand of industry and the Services for more radio engineers has emphasized the continuing difficulties of education and training in this field. Following a series of reports made by the British Institution of Radio Engineers on this subject, a recent meeting of the Institution in London was devoted to examining some of the present problems.

Opening the discussion, Prof. E. E. Zepler (professor of electronics in the University of Southampton) stated that there is now scarcely an industry which does not, in one way or another, use either electrical communications or what is now called industrial electronics. The British Institution of Radio Engineers has recently decided to extend the syllabus of its graduateship examination by including industrial electronics as a specialized subject as from 1956.

The universities have not, so far, final degree courses in radio engineering. Many universities provide specialized papers in communications and radio physics; but all too few universities have, in fact, a chair of radio or electronic engineering. In consequence, education and training in the universities are not a main contribution towards the solution of our man-power shortage and, in the main, recruitment in the industry comes through the technical college.

Prof. Zepler feels that universities which, for various reasons, will not cater for a degree in electronics might be prepared to provide a fourth-year course, devoted wholly to electronics, for those who have taken a degree in physics or in electrical engineering.

Prof. Zepler invited discussion on the question of whether industry co-operates sufficiently with the universities and technical colleges in providing sandwich schemes and part-time release.

He said that the experience of some of the examining bodies, including the British Institution of Radio Engineers and the City and Guilds of London Institute, was that examination results show that students are, in the main, inadequately prepared for these examinations, but suggested that the results are not wholly the fault of the technical colleges; it might well be that basic training at the grammar schools and secondary modern schools is not adequate.

Prof. E. Williams (professor of electrical engineering in University College, Cardiff) said that he has no doubt that, at one stage of the country's educational development, classics provided the quickest and most readily available training in straight thinking. But nowadays we must surely quarrel with the principle that "it doesn't matter what you teach so long as it trains a man to think". The practice of radio and electronic engineering now rests on so extensive a basis of specialized physical principle and of particularized application of mathematics that its study is as much a contribution to true education as is the study of any pure science. The desirable limits of specialization are imposed, not by educational considerations, but by vocational requirements. A very broad study of physical principle is undoubtedly needed, but Prof. Williams holds that, in the limited time available, it is both unpractical and unnecessary to prescribe a similarly broad study of related technologies. Professional institutions have not the same function as universities, and it is reasonable to expect greater specialization in courses leading to the examinations of the former. Prof. Williams thinks that the development of education and training in radio and electronic engineering will be seriously retarded unless the policy of regarding 'electrical engineering' as a convenient indivisible unit of subject-matter is abandoned.

Mr. Hugh Warren (principal of the South East London Technical College) represented the Association of Principals of Technical Institutes at the discussion. He feels that the term 'radio' should not be restricted to the connotation with which it might have started many years ago. Instrumentation, control, radio-frequency heating, radar and an ever-widening field of applications now have to be added to the fields of valve manufacture, telecommunications and recording and amplifying equipment.

Mr. Warren said that perhaps half the 250 or so technical colleges in Britain have seriously concerned themselves with the training of radio engineers. Just as there is no British standard radio engineer, so there is no attempt to prescribe a single course. There are many courses and they reflect the complexity and variety of this rapidly expanding industry. They prepare for a wide variety of qualifications—degrees, diplomas, the National and Higher National Certificates, a number of different City and Guilds Certificates, and the examinations of the professional institutions. These fairly well-defined levels of qualifications blend into each other. Mr. Warren defied anyone to delimit the exact boundaries of a professional engineer. He paid a tribute to the real co-operation both of organized industry and of individuals in industry, in the matter of courses and equipment. After comparing British and French systems of apprentice-training, Mr. Warren asked for guidance on the question of whether a new certificate in radio is needed. In mechanical engineering there is a certificate for those who are not going to be

designers, but are going to be very good technicians, if not technologists. There is nothing quite comparable in radio. Mr. Warren wondered whether the technical college should, as in France, undertake more of the practical side of apprentice-training—or whether industry is content to undertake this. He concluded with a plea that education should find room for social thinking and an awareness of the economic and philosophical problems of our age.

Mr. R. E. Burnett (manager of the Education and Technical Personnel Department of Marconi's Wireless Telegraph Co.), expressing personal views, maintained that the radio industry is playing a full part in co-operation with the universities and technical colleges in stimulating recruitment and in planning the future training and education of radio engineers.

Agreeing that there is still a tremendous shortage of professional engineers in this field, Mr. Burnett stated that the larger companies are spending more and more money in developing their own training schemes, including the provision of the equivalent of college facilities. The smaller, but progressive, firms are in many cases making a proportional contribution to the problem of providing adequate training by co-operating with local technical colleges and in some cases making arrangements with the larger companies who are able to provide their own schemes. He advocated that there might be an extension of this principle in view of the increasing number of organizations which are not at present in a position to set up their own individual training schemes.

Agreeing with Mr. Warren that the question of selection is important, Mr. Burnett feels that too little is done to help the student who fails to reach professional status or even Higher National Certificate level. He advocated that courses and examinations should be so organized as to enable the candidate who cannot reach the higher level to be accommodated in the technician or craft level. Similarly, not enough is done to encourage the successful craft apprentice to go forward to secure professional status.

Some graduates hold the view that, having completed their university training, it is not necessary to follow on with a form of training or apprenticeship course. Most of the larger companies, however, have found that it is to the ultimate advantage of the graduate to undertake further training in the shape of an apprenticeship course, if only to have a first-hand understanding of the working of the various departments which go to make up a large organization. The graduate who leaves the university and is straightway employed on a special task tends to become insular in his outlook and not to use fully his academic training.

In general, the output of the universities is so comparatively small that industry is compelled to look to the technical colleges and the other examining institutions for recruitment to its professional ranks. In return, industry must be conscious of the need for arranging sandwich and similar courses (at present in very small numbers) in order to provide adequate training facilities for able young men who, for one reason or another, cannot undertake a full-time university course.

Other speakers in the discussion dealt with the shortage of teachers. Too many technical colleges are dependent on the services of the part-time lecturer who, by reason of his main job in industry, is unable to give adequate time and thought to teaching.

Mr. E. M. Wareham (chief engineer of Sanders Electronics, Ltd.) feels that there is a serious gap between the standard of training of a university graduate in electrical engineering or physics, and the standard required in the design and development laboratories. The average student has to have at least two years training and general experience before being entrusted with responsible electronic work in the design and development field.

Mr. C. W. Robson (head of the Electrical Engineering Department of the South East London Technical College) feels that very few firms are prepared to enter into an apprenticeship scheme which will give the technical colleges the maximum opportunity of playing their part in the thorough training of the younger man.

The technical colleges are, in the main, dependent on recruitment at the age of sixteen or seventeen years, when the work of the technical college has to be integrated with the activity of the employing firm. In the Ordinary National Certificate, Mr. Robson feels that there should be greater specialization in radio and electronics.

Other speakers expressed the view that industry, and particularly the radio industry, does not do sufficient to publicize in the schools the opportunities available in industry. The first contribution made by the radio industry in this connexion is the excellent booklet distributed by the Ministry of Labour on radio and electronics as a career.

It was suggested that a difficulty in persuading youth to go in for a radio engineering career is the fact that, in the first two or three years of technical college training, students are confined to training in electrical engineering. Mr. W. Dunn expressed the belief that, if the radio apprentice could, in his first three-year technical college course, secure acknowledgment and reward in the shape of an Ordinary National Certificate in Radio Engineering, his interest would be much better maintained than under the present arrangement of expecting him to take an ordinary National Certificate in electrical engineering before starting any serious study of radio and electronics.

E. Williams

OBITUARIES

Sir Shanti Bhatnagar, O.B.E., F.R.S.

On New Year's Day, India lost a great public servant, Sir Shanti Swarup Bhatnagar, a man of exceptional ability and immense energy. As director of the Council of Scientific and Industrial Research, secretary of the Ministry of Scientific Research, and chairman of the University Grants Committee, he was the Prime Minister's right-hand man in implementing the policy to put science in the forefront of India's plan for the future. When inaugurating the forty-second session of the Indian Science Congress at Baroda on January 4, Mr. Nehru paid him tribute: "I have co-operated for the last six or seven years or more with Dr. Bhatnagar who, I think, has done—I say this with all respect due to others—more than anyone else for scientific development in India".

Twelve new national institutes and laboratories have been built, equipped and established in various

centres in India* during the past six years, and most of them are now in full operation. Anyone who has seen these institutes cannot but be astounded by the energy and drive of the man who in so short a time created them. Bhatnagar could well be called a master builder, for there is a unity of conception, and every detail, even the fountains in the gardens, had some special object emanating from his ideas. In the words of Dr. H. J. Bhabha, "in the short space of a few years Bhatnagar built the laboratories which are indispensable to any nation which aspires to leadership in the modern world, and he has provided the means whereby young Indian scientists of to-day and to-morrow can make their contribution to the betterment of India and its people". These laboratories will be an enduring monument to the imagination, enthusiasm and patriotism of Bhatnagar, who spared himself not at all. He travelled far and wide to seek the latest designs, the most suitable equipment, the recent techniques which would help to promote the efficiency of his laboratories. He was undeterred, he went ahead and got things done—he did not permit finance to baulk his objectives and yet they were achieved at remarkably reasonable cost owing to his exceptional foresight and ingenuity.

Although this chain of laboratories is Bhatnagar's great achievement, it absorbed only part of his energies as secretary of the Ministry of Scientific Research and as director of the Council of Scientific and Industrial Research with its numerous committees and activities. He was the mainspring of it all, and he had his finger on every detail of the Council's work. He possessed a clear, concise and well-docketed mind. He was the first to arrive at the secretariat and his light was the last to go out; driving his assistants hard, he drove himself harder. He had a kind heart and a keen sense of humour, and they appreciated the joy and privilege to work for him.

As chairman of the University Grants Committee, he had undertaken a further great and important task. Sir A. L. Mudaliar, vice-chancellor of the University of Madras, stated that "Bhatnagar had just got into full stride as Chairman and it was a great misfortune that at this stage the Commission should be deprived of his forceful personality, and his wisdom and guidance".

Alas, the strain of all this work for India and for science was too great, and in his sixtieth year his heart suddenly failed.

Bhatnagar was born in a small township near Delhi in 1895—the Prime Minister was present at his birthday celebrations held at the National Physical Laboratory (Delhi) last February—and the devotion accorded to him and the respect for his achievements must have pleased him. His father was a teacher at Bhera in the Punjab; but he died when Bhatnagar was only eight months old. He often spoke of his mother and the great influence she had on him during his early days at school, when with considerable struggle but great innate ability he managed to acquire the knowledge for entry to the Forman Christian College, Lahore. There he came under the influence of able professors, and took his M.Sc. in chemistry in 1918 in the University of the Punjab. In 1919 he came to England and obtained admission to University College, London, where he worked under Prof. F. G. Donnan, for whom he had great esteem and affection. In 1920 he obtained a grant-in-aid from the Department of Scientific and Industrial Research and continued working on the stability and inversion of oil–water emulsions, and secured the D.Sc., University of London, in 1921. After that he spent some months in Europe, at the Sorbonne and at the Kaiser Wilhelm Institute (Berlin), and was then appointed professor of chemistry in the Benares Hindu University, where he remained until 1924, having started a centre of physical chemical research. In October 1924 he became professor of chemistry and director of the University Chemical Laboratories, University of the Punjab, Lahore, which post he held for sixteen years. This was his most active and fruitful period of research, during which he published many papers on physical chemical subjects—colloids, surface chemistry, photochemistry, and particularly magneto-chemistry. He published, with K. N. Mathur, "Principles and Applications of Magneto-Chemistry", and devised with him an interference balance for magnetic measurements. His research in magneto-chemistry gained him election to the fellowship of the Royal Society of London in 1943.

Bhatnagar was, from all accounts, a very inspiring teacher; it was as a teacher that he himself was most happy. He took great trouble about his pupils, and many were the unbeknown acts of kindness and generosity. Not only was he a teacher of chemistry with a power of original work, but also he was widely read, and a gifted writer. His Urdu poetry, which was cast in a light vein, was much appreciated. His interests were wide, he was gay in conversation, lively in debate, and a wonderful friend. He had an unprejudiced outlook, having travelled widely and having many friends in many countries. Albeit, he was a great patriot and ambitious for India's sake.

In 1940, Lord Linlithgow (then Viceroy of India) was looking for a man to help to establish a government organization on the lines of the Department of Scientific and Industrial Research in Great Britain. He wisely chose Bhatnagar. Thereafter Bhatnagar became more closely linked with the Government machine at Delhi. It would have been difficult anywhere to find a man of more varied accomplishments, with such energy and drive. He had already had close connexions with industry. During his time at Lahore, he had devised processes relating to the purification of kerosene oil which proved helpful to Messrs. Steel Bros. It was characteristic of Bhatnagar to turn over emoluments received to public benefit, and he arranged with the company to found the Steel Bros. Research Scheme, which could be employed for research scholarships in the Punjab University Chemical Laboratories. Such schemes were extended when further ideas led to support for research from other oil industries.

It was in connexion with his activities while still at Lahore that he was made O.B.E. in 1936. He was knighted for his services on behalf of the Government in 1941.

During the Second World War and in connexion with the work of the Council of Scientific and Industrial Research, Bhatnagar's ideas fertilized many activities—for example, the production of anti-gas cloth and varnishes, foams, vegetable oil blends as substitutes for lubricating oils, glass substitutes, synthetic

* National Physical Laboratory of India (Delhi); Central Road Research Institute (Delhi); Central Building Research Institute (Roorkee); National Chemical Laboratory of India (Poona); Central Food Technological Research Institute (Mysore); Central Electrochemical Research Institute (Karaikudi); Central Leather Research Institute (Madras); Central Glass and Ceramic Research Institute (Calcutta); National Metallurgical Laboratory of India (Jamshedpur); Central Fuel Research Institute (Dhanbad); Central Drug Research Institute (Lucknow); Central Salt Research Institute (Bhavnagar).

resins and plastics from waste products. He was the owner of a number of patents relating to textiles, wood products, mineral waxes, etc. He was in touch with all the chief industrialists in India and had connexions with many leading technologists in other countries; furthermore, he was skilled in negotiation, so that, with his experience in university life and his many personal scientific friends, he became invaluable as the centre of the growing scientific organization within the Government of India. When national independence came, the schemes on which his heart was now set quickly took shape. Some of them, indeed, had already been decided (for example, the building of a National Physical Laboratory).

Bhatnagar took a leading part in starting a number of projects, such as the formation of Indian Rare Earths, Ltd., for the processing of monazite sands and the search for atomic minerals. A number of metallurgical and chemical processes were developed or changed to suit Indian conditions and India's needs; for example, the enrichment of manganese ores proved a valuable enterprise.

His administrative successes were frequent; it may be mentioned that he was successful in gaining exemption from tax for expenditure on research, and from customs duties on scientific instruments essential for research. He was active in promoting the regional technological institutions, the Standards Institution and the National Research Foundation, and was a very useful member of the Council of the Indian Institute of Science, Bangalore. He instituted a documentation centre which was accommodated in the National Physical Laboratory building.

Bhatnagar took a lead in all that was going on in science in India. Before the War he had been sectional president (chemistry) of the Indian Science Congress (1928 and 1938). He was general president in 1944–45. He was president of the National Institute of Science of India (1947 and 1948), and as president in his address at the thirty-sixth session of the Indian Science Congress, he appealed to the young scientists of India for zeal in the cause of science and its application and zest for research.

He attended many conferences in foreign lands, as representative of India. He was a delegate to the Empire Universities Congress at Edinburgh (1931) and at Cambridge (1936); to the British Association and the Michael Faraday centenary celebrations (1931), and at the Liverpool meeting so far back as 1923. He was a member of the Indian Scientific Mission for the Government in 1945 and leader of the official delegation at the Empire Scientific Conference in 1946, and a member of the Indian Atomic Energy Commission which visited Great Britain in 1948. He attended the United Nations Scientific Conference on Utilization and Conservation of Natural Resources in New York, 1948. He made many tours to Europe and America in connexion with his work, and these included recently visits to the U.S.S.R. and to South America.

Bhatnagar was an honorary D.Sc., Oxford (1946), and had received the honorary doctorate of Delhi, Allahabad and Patna, and was honorary professor of chemistry of the Universities of Delhi, Benares and the Punjab. He was a Fellow of the Syndicate and member of Council of Benares University. He was a Fellow of University College, London. He was a Fellow of the Institute of Physics and of the Royal Institute of Chemistry (London), and was made an honorary member of the Society of Chemical Industry (London) in 1943 and honorary vice-president (1945–48). He was a past-president of the Indian Chemical Society and recipient of the Reddy Prize in Chemistry, 1947.

The joy of Bhatnagar's full, eager life was marred by the loss of his wife, Srimati Iajwanti, in 1945. He had two sons and two daughters. A son and daughter-in-law lived with him, and his home-life was still a happy one. He had a little farm outside Delhi in which he took great pleasure. But one could not imagine his tireless soul resting at ease in this world while there was work to be done. Providence ordained that he should suddenly be taken away so that others, by the very shock of his loss, may be fired with his zeal. He has provided the means for scientists in India in many branches of science to do great work.

Alfred C. Egerton

Dr. G. F. C. Searle, F.R.S.

A memorial service for the late Dr. G. F. C. Searle, a former Fellow of Peterhouse, Cambridge, who died on December 16, was held in the College Chapel on January 21, at which colleagues, former pupils and friends gathered as a tribute to the passing of a notable personality.

Searle was the son of the late Rev. W. G. Searle and was born in the vicarage at Oakington, Cambridgeshire, on December 3, 1864. His ninetieth birthday was celebrated by a tea-party at the Cavendish Laboratory on December 3 last, when a large and distinguished company heard him give an account of his boyhood and youth, and of his introduction to physics when taken by his father to see the newly erected Cavendish Laboratory and shown over the building by James Clerk Maxwell, then recently appointed the first Cavendish professor of experimental physics.

Searle won a foundation scholarship at Peterhouse and, entering the University, read for the Mathematical Tripos, which he took in 1887, being classed as a Wrangler. In the following year he studied physics for Part II of the Natural Sciences Tripos. He began research work in 1888 in collaboration with Prof. J. J. Thomson on a determination of the ratio of the electromagnetic unit of electricity to the electrostatic unit, a research which was published in the *Philosophical Transactions of the Royal Society*. This was followed by many independent publications, mostly dealing with magnetic measurements or electromagnetic theory, but occasionally with properties of matter or heat. These researches gained for him the fellowship of the Royal Society in 1905 and the award of the Sc.D. degree by the University of Cambridge in 1912.

Searle was appointed to a University demonstratorship in 1890 and to a University lectureship in 1900. He retired from both posts in 1935. At the outbreak of the Second World War, however, he returned to work again and only gave up finally, and with reluctance, at the age of eighty-three, having then worked under three Cavendish professors. Sir J. J. Thomson has placed it on record in his book, "Recollections and Reflections", that "Searle has done more for the teaching of practical physics at Cambridge than anyone else". He taught a large class in practical physics at the Cavendish Laboratory —that for students working for Part I of the Natural Sciences Tripos—and for more than forty years nearly every Cambridge man taking physics was at some time his pupil. On the occasion of his ninetieth

birthday party, Searle claimed with pride to have taught more Fellows of the Royal Society than any other teacher, and also that both the father and the mother of the present Cavendish professor had been his pupils.

As a University lecturer Searle gave regular courses of lectures for Part II of the Tripos in classical electricity and magnetism and in heat. He also, for a time, gave lectures on mathematics for students of physics. But it was his work as a demonstrator which gave him his pre-eminence. He showed great skill in devising laboratory experiments suitable for instructing students, and in designing the necessary apparatus. It is these skills which have carried his name and his teaching methods into the physics departments of almost every university and technical college in the world, and into the science laboratories of most progressive schools. His experiments were never commonplace; their originality and elegance made a special appeal to students, so that they became keen to try them. With each experiment he supplied a manuscript, written in his own hand, giving an account of the underlying theory, followed by a very full and clear description of the way the experiment should be made. Some of these manuscripts have been published by the Cambridge University Press in a series of volumes. Displayed on the notice-board of his laboratory was a list of instructions and exhortations to students beginning work in practical physics. To many, the last paragraph of these was the most interesting. It dealt with the relations between students and their hard-worked demonstrators, exhorting students not to become annoyed if they did not get all the attention to which they felt entitled, but to be patient and remember that "demonstrators are only human and need your sympathy and your prayers at least as much as other men".

Dr. Searle married, in 1904, the widow of Mr. Thomas Parsons, of Wimbledon, and would speak most feelingly of the great help and constant encouragement he had received from her throughout their happy married life. He was above all a staunch Christian. He was active as a lay reader of the Church of England and keen and enthusiastic about any duties he undertook. As a teacher his manner was perhaps rather brusque and a little forbidding to students meeting him for the first time; but his obvious earnestness and lively interest in them and their work soon overcame this, and he was held in respect and admiration by a large circle of students and friends.

FRANK HORTON

NEWS and VIEWS

Rothamsted Experimental Station: Dr. R. K. Schofield

THE appointment of Dr. R. K. Schofield to be head of the Chemistry Department of Rothamsted Experimental Station, in succession to the late Dr. E. M. Crowther, is a tribute to his versatility. He went to Oundle School and won an entrance scholarship to Trinity College, Cambridge, in science and mathematics. He took physics, chemistry and botany in Part I of the Natural Sciences Tripos, and his progress was marked by the winning of a senior scholarship and a first class in Part II (Physics). His special interest in the borderland between physics and chemistry led him to do his Ph.D. research on the physical chemistry of surfaces under Sir Eric Rideal. For two years he was lecturer in physics at Durham and then joined the Physics Department at Rothamsted, of which he became the head in 1947 in succession to Sir Bernard Keen. He is a recognized authority in the moisture relationships and colloidal aspects of soil, and in recent years has been particularly active in applying and extending the concept of the diffuse electric double layer. He has been chairman of the Colour Group of the Physical Society and was visiting professor of soil physics at Cornell University during the winter of 1951–52.

Dr. H. L. Penman

DR. SCHOFIELD is succeeded as head of the Physics Department at Rothamsted by Dr. H. L. Penman, who graduated in the Newcastle Division of the University of Durham in 1930 with a first in physics. After research in acoustics with Dr. E. G. Richardson, he joined the Photochemistry Section of the British Cotton Industry Research Association in Didsbury, leaving in 1937 to go to Rothamsted. Until 1941 he worked on diffusion of gases and vapours in soil, soil temperature, and on drainage and evaporation. During 1941–44 Dr. Penman was in the acoustics section of the Mine Design Department, Admiralty, at Portsmouth. In 1944 he returned to Rothamsted to resume his evaporation studies, and since then has been able to show that the use of water by vegetation is a physical process the rate of which is dictated by weather, and is calculable from weather data. The general utility of this work in irrigation control and in hydrology led to an invitation from the Waite Agricultural Research Institute, Adelaide, to spend six months in Australia (1951–52), where, supported by a Nuffield Fellowship, Dr. Penman was able to study the water conservation and irrigation problems of south-east Australia. Dr. Penman has been honorary secretary of the London Branch of the Institute of Physics, has served on the board of the Institute, and at present is an honorary secretary of the Royal Meteorological Society and a vice-president of the Association Internationale d'Hydrologie Scientifique.

Zoology at Fordham University: Prof. A. A. Wolsky

PROF. A. A. WOLSKY, former professor of zoology in the University of Budapest and director of the Hungarian Biological Research Institute at Tihany, has been appointed professor of experimental embryology in Fordham University, New York. Following his formal education in Budapest, Dr. Wolsky did postgraduate work abroad under fellowships from the Hungarian Government, the Rockefeller Foundation and the Swedish Institute of Cultural Exchange. This included studies in London in 1931, Cambridge in 1934, and at the Wenner Gren Institute, Stockholm, in 1935. In 1947 the Hungarian Government permitted him to return to Stockholm for a year. At the end of that period he refused to return to Hungary. He joined Unesco as principal scientific officer for South-East Asia, stationed at Djakarta, Indonesia. He has held that position for six years. Dr. Wolsky is the author of

"Genetics and the Origin of the Species" and "Biological Lexicon". His published papers deal largely with problems of experimental embryology and embryological genetics.

The Canadian Defence Research Board

Mr. E. Ll. Davies, vice-chairman of the Canadian Defence Research Board, has resigned and has been succeeded by Mr. A. H. Zimmerman, a prominent Canadian engineer. Dr. G. S. Field, formerly scientific adviser to the Chief of the Naval Staff, has been appointed chief scientist. Dr. N. W. Morton, chief of the Division involving operational and medical research, human resources and environmental protection, and Dr. John W. Abrams, superintendent of the Board's Operational Research Group, have been appointed scientific advisers to the Chief of the General Staff and the Chief of the Air Staff, respectively. Dr. F. H. Sanders is to become scientific adviser to the Chief of the Naval Staff. Mr. G. M. Carrie, whose Division is concerned with special weapons and northern activities, and Dr. J. J. Green, chief of the Division which directs activities in the fields of armaments and aeronautics, will combine with their present duties the task of increasing and reorganizing the headquarters' scientific staff. Dr. William Petrie has been appointed acting superintendent of the Operational Research Group.

Shipbuilding Research in Britain

A meeting of the Parliamentary and Scientific Committee on December 7 was addressed by Mr. Charles Connell, chairman of the British Shipbuilding Research Association, and by Dr. S. Livingston Smith, the director of research, on recent developments in research and technology in the British shipbuilding industry. Mr. Connell, who limited himself chiefly to questions of policy, pointed out that British shipbuilding has a long history of technical progress and cannot be accused of backwardness in applying scientific ideas. It should be remembered, moreover, that a ship and its machinery represent a capital investment of the order of £1 million with a working life of more than twenty years. Mr. Connell, however, is concerned about the question of publication of research results, and urged that results likely to benefit industry should only be communicated to British industry in the first instance. In shipbuilding research, the policy is to send all research results first to member firms in confidence, and later the commercial advantage of each report is assessed on its merits before a decision about publication is taken. Mr. Connell also pleaded for further financial support from the Government for the Research Association, in view of foreign competition.

Dr. Livingston Smith, in his paper, gave some details of the work of the Association, much of which is undertaken extra-murally and on board ship. The Association has shown that reductions of up to five per cent in frictional resistance of a ship's hull can be obtained by a better finish on the painted surface, and tests at Glengarnock on full-scale components of ships' structures have led to improvements in construction and large savings of steel. A comprehensive series of tests of propulsion and resistance carried out in ship-model testing tanks on a range of models of ocean-going merchant ship forms have yielded data of great value to designers; and investigations on noise have led to the adoption of less expensive methods than that of acoustic lining in the engine room and elsewhere. Investigations into the causes of crankcase explosions and their prevention promise to reduce considerably this hazard.

Nuffield Foundation: Ten Years Grants

The Nuffield Foundation has now published the second part of its review of its first ten years (pp. 319. The Foundation, London, 1954), which was promised when the review of the main policies pursued and the kinds of work supported was issued in 1953 (see *Nature*, 171, 851; 1953). In doing so, however, that admirable first part has been incorporated in the appropriate sections of this report, so that this new volume gives a more detailed record of the grants themselves and the progress made, to which are appended complete lists of Nuffield Foundation Fellows, Scholars, Bursars, etc., appointed during the first ten years and published research attributed, in whole or in part, to the Foundation's grants and awards; in this way it provides a clear guide to the policies pursued and the principles determining grants. The first part is thus entirely superseded by the second save only where it may be a convenience to have the general account run consecutively and unbroken by detail. Be that as it may, this report on grants made during the ten years April 1943–March 1953 will stand on its own as an authoritative and well-arranged reference work on the Foundation's activities during that decade. There is an adequate index. This admirably written account of the way in which the private and independent institution can still function in the Welfare State provides a most impressive vindication of the principle of voluntary action.

Fellowships, Scholarships and Bursaries

The Nuffield Foundation is offering a number of scholarships and bursaries for postgraduate training in biology and sociology. Those in biology are intended for graduates in physics, chemistry, mathematics or engineering; those in sociology for graduates in the natural sciences and the humanities. Applicants should be 22–35 years of age and normally resident in the United Kingdom. The scholarship is valued at £500–600 a year (plus fees), with certain allowances for married holders; a bursary is valued at £350 a year (plus fees), also with certain allowances. Applications for the biological awards must be made by April 1; those for the sociological by May 1. The Foundation is also offering fellowships and scholarships in dentistry in order to enable holders with dental qualifications to receive such additional training in pure and applied science as is desirable to fit them for an academic career in dentistry or to assist university graduates in medicine or science in receiving training which will qualify them to undertake teaching and fundamental research in dental health and disease. A fellowship is valued at £500–800, with travelling expenses; a scholarship covers tuition fees and a subsistence allowance of up to £200 a year. Applications for fellowships must be made by March 1; those for scholarships by June 30. Further information can be obtained from the Director, Nuffield Foundation, Nuffield Lodge, Regent's Park, London, N.W.1.

Statistical Methods in Industry

The International Statistical Institute has just begun publication of the *International Journal of Abstracts on Statistical Methods in Industry* (annual subscription 2.50 dollars (18*s*. or 9.50 guilders), from the Institute, at 2 Oostduinlaan, The Hague, Nether-

lands), and three issues have now appeared. This bibliographical work is to appear three times a year and each issue will contain about a hundred abstracts of papers on the application of statistical methods in industry and technology published in all parts of the world. It is the intention of the editors to prepare the abstracts in such a manner that the reader will be able to judge whether or not the original article would be of interest to him. 'Industry' will be interpreted broadly to include transport, mining, generation of electric power and management problems in agriculture (but not agronomy). Theoretical papers that have direct industrial and engineering applications will be included. The abstracts will be in English or in French, and printed on one side only of thin cardboard, so that they can be cut out and filed as 3 in. × 5 in. cards. Industrial statisticians who are willing to co-operate in the preparation of abstracts are invited to communicate with the appropriate regional editor; for the United Kingdom, he is Dr. E. H. Lloyd, Department of Mathematics, Imperial College of Science and Technology, London, S.W.7.

Decay of Wood in Boats

BULLETIN No. 21 of Forest Products Research, Department of Scientific and Industrial Research (London: H.M. Stationery Office, 1954), deals with "Prevention of Decay of Wood in Boats". In the days when all ships and boats were built of wood, the problem was a serious one because the nature of the decay was not understood and so no prevention or cure could be applied. In the eighteenth and nineteenth centuries naval authorities were seriously alarmed at the rapidity with which timbers in wooden battleships deteriorated and many remedies were tried without success. During and since the Second World War the problem has again become prominent owing to the increasing number of less-durable timbers in use. This bulletin is the result of a discussion between naval architects, representatives of boat-building firms and officers of the Forest Products Research Laboratory. As would be expected, the decay is found to be most serious in vessels which are laid up for parts of the year or are held in reserve. The bulletin describes with diagrams the fungi responsible for this decay and the conditions under which they develop. The decay is frequently alluded to by the term 'dry rot', which is caused by the fungus *Merulius lacrymans*. The name should be avoided, as this fungus is seldom found on a boat. The commonest wood-destroying fungi known to occur in boats are *Coniophora cerebella* (the cellar fungus) and species of the genus *Poria*. Methods for eradicating decay and preventing its development in new craft by the use of naturally durable timbers and modern wood preservatives are outlined.

Oil Palm Research

WITH the appearance of the second number of the *Journal of the West African Institute for Oil Palm Research* (September 1954), this new publication may be said to have got fairly into its stride. It promises to be of great value to all who are concerned with this important tropical crop. It combines in a useful way up-to-date investigations both of an applied and of a more fundamental character, while the critical reviews of other publications relating to oil palm matters seem likely to confer on the journal a centralizing and integrating function. The present number includes articles on the improvement of natural palm groves—an important domestic consideration in Nigeria, where most of the palm oil comes from this source—and the effect of cultural treatments on losses in the nursery. A sound foundation for future work on the diseases of the oil palm is provided by a preliminary account, with descriptions, illustrations and diagnostic key, of all the diseases thus far encountered in Nigerian territory. As the oil palm is often grown on somewhat, or even highly, impoverished soils, deficiency diseases assume a considerable magnitude from the point of view of both production and research. One of these diseases, described as orange frond, has now been shown to be due to magnesium deficiency and can be remedied by appropriate treatment. A further article relates to two new caterpillar diseases which may cause considerable destruction of palms.

Zoological Nomenclature

As from July 31, the International Commission on Zoological Nomenclature will start to vote on the following cases involving the possible use of the plenary powers for the purpose specified against each entry. Full particulars of these cases have been published on January 31, 1955, in Parts 1 and 2 of vol. 11 of the *Bulletin of Zoological Nomenclature*. (1) *Pleurotomaria* Sowerby (J.), 1821, validation of (if judged to be invalid); *anglicus* Sowerby (J.), 1818 (*Trochus*), validation of, and designation of, as type species of *Pleurotomaria* (Cl. Gastropoda); (2) *Pachyceras* Bayle, 1878 (Cl. Cephalopoda, Order Ammonoidea), validation of; (3) *Neanura* McGillivray, 1893, and *Hypogastrura* Bourlet, 1839, designation of type species for; *Achorutes* Templeton, 1835, suppression of (Cl. Insecta, Order Collembola); (4) *Crenophilus*, validation of, as from d'Orchymont, 1942; *aeneus* Germar, 1824 (*Hydrophilus*), validation of (Cl. Insecta, Order Coleoptera); (5) *Rhinopteraspis* Jaekel, 1919, validation of (Cl. Ostracodermi); (6) *Anurophorus* Nicolet [1842], designation of type species for (Cl. Insecta, Order Collembola). Attention is directed also to the proposed suppression of the generic name *Jumala* Friele, 1882, as a name calculated to give offence on religious grounds. The above Parts also contain proposals for the adoption of three 'Declarations': (*a*) relating to transliteration of words normally written in Cyrillic characters (preliminary to insertion in the Code as a schedule (Copenhagen decision)); (*b*) defining the status of a generic name published conditionally; (*c*) clarifying Rule (*f*) in Article 30 (type species of a nominal genus established as a substitute for a previously established such genus but with a different type species). Comments on the above cases should be sent as soon as possible to Mr. Francis Hemming, Secretary to the Commission, 28 Park Village East, Regent's Park, London, N.W.1.

The National Science Foundation, Washington

THE National Science Foundation, Washington, has announced 216 grants totalling about 2,650,000 dollars for the support of basic research in the natural sciences, for conferences and studies on science, scientific information exchange, for scientific manpower, and for travel of American scientists to international scientific meetings. This is the first group of awards to be made during the fiscal year 1955 by the Foundation for the support of basic research and related matters. Since the beginning of the programme in 1951, more than 1,100 such awards have been made, totalling about 11,141,000 dollars. In addition, the first grant, totalling 100,000 dollars,

was made under a special appropriation for the International Geophysical Year. The research fields included are astronomy, chemistry, developmental biology, earth sciences, engineering sciences, environmental biology, genetic biology, mathematical sciences, molecular biology, physics, psychobiology, regulatory biology, and systematic biology. A list of the grants, including institution, name of principal scientist, title, duration and amount, can be obtained from the Secretary, National Science Foundation, Washington 25, D.C.

Ulster Folk Museum

The *Museums Journal* of December 1954 announces that the Committee appointed by the Northern Ireland Minister of Finance has recommended in its report that an Ulster Folk Museum be established in the grounds of Belfast Castle at a probable cost of £60,000. The Museum would consist of buildings, implements and other objects displayed in a natural setting and under living and working conditions. Buildings of a traditional type would be rebuilt or copied and so far as possible put to their original use. The Committee suggests that the Museum should be established on a national basis, with substantial Government financial backing. The Corporation of Belfast has already agreed to make available at a nominal rent some 5½ acres in the grounds of the Castle.

Leicester Museum and Art Gallery

The forty-eighth report of the Committee of the Leicester Museum and Art Gallery records the opening to the public of the herb garden and Deacon Clock workshop in Castle View. The new garden and the reconstruction illustrating one of Leicestershire's oldest industries provide, on the site of what was formerly a builder's yard, an amenity which has transformed this corner of old Leicester. The report is issued in an attractive form, and interesting acquisitions are recorded.

Colonial Service: Recent Appointments

The following appointments have recently been made in the Colonial Service: A. L. Job (inspector of mines, Tanganyika), inspector of mines, Uganda; R. B. J. Deane, tea officer, Agricultural Department, Mauritius; K. G. Windsor, agricultural officer, Northern Region, Nigeria; B. J. Gee, fisheries officer, Northern Region, Nigeria; R. G. Dixon, assistant conservator of forests, Federation of Malaya; A. W. Gunthert, mineralogist, Federation of Nigeria; A. G. Royle, inspector of mines, Tanganyika; J. A. Armstrong, entomologist, East Africa High Commission; J. B. Davies, entomologist, Sleeping Sickness Service, Northern Region, Nigeria.

Planned Parenthood

The fourth International Conference on Planned Parenthood was held at Stockholm during August 17–22, 1953, at the invitation of Riksforbundet for Sexuell Upplysing (National League for Sex Education) and was attended by 158 delegates and observers from twenty-one countries. A report on the proceedings has now been published and includes papers on such topics as world population trends and their relation to food supplies, current experiments in birth control, termination of pregnancies, sterilization, subfertility, sterility, artificial insemination, marriage counselling and sex education. Great Britain was represented on the organizing committee by Mrs. Margaret Pyke and Dr. Helena Wright on behalf of the Family Planning Association. This interesting and informative report may be obtained from the International Planned Parenthood Federation, 69 Eccleston Square, London, S.W.1, price 10*s.* 6*d.*

Symposium on Condensation Nuclei

A symposium on atmospheric condensation nuclei will be held in the School of Cosmic Physics of the Dublin Institute for Advanced Studies, 5 Merrion Square, Dublin, during April 26–28. Papers may be read and contributions to the discussions made in English, French, German or Italian; interpreters will be provided during the session. Papers from France, Great Britain, Ireland, Italy, Sweden, Switzerland, the United States and West Germany have already been promised. Notification of attendance must reach Prof. L. W. Pollak, at the Dublin Institute for Advanced Studies, before April 10.

Announcements

H.R.H. the Duke of Edinburgh has been elected an honorary member of the Institution of Electrical Engineers.

Dr. J. N. Hunt, senior lecturer in Guy's Hospital Medical School, has been appointed to the University of London readership in physiology tenable at that School.

Mr. Cecil Warburton, entomologist, formerly of the School of Agriculture and the Molteno Institute, University of Cambridge, who celebrated his hundredth birthday last year (see *Nature*, February 13, 1954, p. 289), was one hundred and one on February 6.

The fourth World Petroleum Congress will be held in Rome during June 6–15. Further information can be obtained from the General Secretariat, Via Tevere 20, Rome.

An International Symposium on Electrical Discharges in Gases will be held in the Technical University, Delft, during April 25–30. Further information can be obtained from A. W. van Wagensveld, Mijnbouwplein 11, Delft. Netherlands.

An international conference on "Non-destructive Testing of Materials" will be held in Brussels during May 23–28. Further information can be obtained from the Secretary, l'Association des Industriels de Belgique, 29 Avenue André-Drouart, Auderghem, Brussels.

The sixteenth General Assembly of the Fédération Internationale Pharmaceutique will be held in London during September 19–23. Further information can be obtained from D. F. Lewis, Pharmaceutical Society of Great Britain, 17 Bloomsbury Square, London, W.C.1.

A summer school in programme design for automatic digital computing machines will be held in the University Mathematical Laboratory at Cambridge during September 12–23. Further information can be obtained from G. F. Hickson, secretary of the Board of Extra-mural Studies, Stuart House, Cambridge.

As already announced, the Fourteenth International Congress of Pure and Applied Chemistry is being held in Zurich during July 21–27. Registration for attendance must close on February 15. Correspondence should be sent to the Secretary-General, XIVth International Congress of Pure and Applied Chemistry, Zurich 1.

THE BIOLOGICAL COUNCIL: A PROGRESS REPORT

By Dr. W. P. K. FINDLAY

TEN years have now passed since the first moves were made to bring into being an organization that would enable British scientific societies in the biological field to collaborate in matters of mutual concern, and it may be of interest to survey what has been achieved in this direction.

Many biologists had felt for some time that the activities of the specialized societies to which they belonged remained largely unknown to other biologists who happened to belong to different societies or associations, although often the activities of these other societies were of direct interest to them.

On the initiative of the Biochemical Society, representatives of some eight other societies attended an informal meeting on September 22, 1944, and agreed that steps should be taken to establish a co-ordinating committee consisting of representatives of the biological societies. Thus the Biological Council came into being in July 1945, and in November of the same year, at a meeting held under the chairmanship of Sir Henry Dale, its officers were appointed and a programme of activities suggested (*Nature*, **156**, 713; 1945).

One of the first tasks undertaken was the preparation of an annual calendar containing information about the affiliated societies and the dates of their meetings. This has appeared in one form or another each year since then, and has proved of great value to secretaries, who have thereby been able to avoid undesirable clashes in the dates of meetings of societies having similar interests.

In response to a demand from a number of biologists, a scheme was established in 1947 by which reprints of the titles of papers in the tables of contents of a group of journals were circulated soon after publication. This scheme ran quite successfully for a number of years; but it was discontinued in 1953 owing to an inadequate number of subscribers.

At the time when the Council was formed it was agreed that it should not concern itself with any professional matters affecting biologists themselves or their careers. A sharp cleavage of opinion was revealed at the early meetings when this subject was raised by certain delegates, and at that time it would have been fatal to the success of the Council if professional matters had figured on its agenda. However, in 1946 the Association of British Zoologists invited the Council to consider the need for an Institute of Biology, and the Institute officially came into being as an independent organization on January 5, 1950 (*Nature*, **165**, 131; 1950). It was, however, felt that some continuing form of association between the two bodies was desirable and would lead to economies in the running of the Council business; so, in 1951, the Council became an advisory scientific committee to the Institute, which undertook to carry out the routine secretarial work of the Council. This arrangement has since worked well and to the mutual advantage of both bodies. Following this reconstitution of the Council in 1952, Dr. W. P. K. Findlay was elected chairman, Prof. F. L. Warren honorary treasurer, and Dr. J. L. Cloudesley-Thompson honorary secretary. In 1954, Prof. C. T. Ingold became chairman.

Societies the membership of which approaches four figures often find that the amount of routine secretarial work becomes too much for honorary secretaries to handle, and recently several such societies affiliated to the Council have arranged for this work to be carried out by the staff of the Institute. The provision of such secretarial assistance in a central office was one of the original objects of the Council, and it is hoped that it will be possible to develop these facilities still further.

Several meetings have been held of the editors of the principal biological journals (including some that were not connected with the societies affiliated to the Council) to discuss problems of common interest. Among proposals that were submitted to the Council at an early date was one suggesting some form of conjoint publishing bureau that would hold stocks of reprints and distribute them to individuals. This received little support, and it was at once clear that societies regarded the complete independence of their journals as an exceedingly important principle. However, a number of useful suggestions were put forward at these meetings, on which action was afterwards taken. For example, many editors observed how much time had to be spent correcting literature citations in the manuscripts submitted to their journals, because these did not conform to the abbreviations given in the "World List of Scientific Periodicals". It was therefore decided that a selected list of the abbreviations of the titles of the biological journals to which reference is most frequently made should be prepared. Mr. R. W. Marsh, editor of the *Annals of Applied Biology*, kindly undertook this task and, with the co-operation of the "World List" authorities, a list was prepared and published in 1949, a second edition following in 1954.

In 1947 the Keeper of the Science Library sought the assistance of the Council in obtaining the consent of its associated societies to permit photocopying of copyright papers published in their journals. In general, a favourable response was forthcoming, and permission to reproduce photographically articles in all but the current issues was willingly accorded by most of the societies involved.

The poor delivery of scientific papers by inexperienced speakers often seriously detracts from their interest to the audience, so that accounts of fundamentally interesting work frequently do not receive the attention which they merit. Some "Notes for Speakers" were therefore prepared by the Biological Council in order to assist speakers at scientific meetings in the same way as "Instructions to Contributors" are issued to guide authors contributing papers to scientific journals. These "Notes", which were first published in the *Annals of Applied Biology* in 1954, are available to members of the Institute of Biology and to members of affiliated societies.

An obvious duty of the Council is to promote joint discussions between societies and groups of biologists who are interested in similar problems in related fields. The Council welcomed an invitation in 1951 from the Fine Chemicals Group of the Society of Chemical Industry to co-ordinate symposia on drug action, and a committee, under the chairmanship of Sir Charles Harington, was set up for this purpose. A number of highly successful symposia on subjects such as "Anticholinesterases", "Chemotherapy of

Tuberculosis" and "Insecticides" have already been held.

The Council has been consulted on a number of occasions regarding various aspects of the teaching of biology, such, for example, as the teaching of human biology in schools, and it was asked to nominate a representative to serve on a national board to consider the recruitment and training of laboratory technicians.

Many other minor matters have been dealt with by the Council; but perhaps one of the most important incidental benefits which members have derived from attendance at its meetings has been the personal contact between the officers of various societies and associations.

MEDICAL RESEARCH LABORATORY OF VOJVODINA, NOVI SAD, YUGOSLAVIA

By Dr. P. SCHWARZ
Director

IN 1947 it was announced in these columns[1] that a Yugoslav State laboratory was to be founded in Novi Sad, with the task of dealing with problems of experimental biology and medicine. For certain administrative reasons the laboratory was transferred to Belgrade, and the director, Dr. P. Martinovitch, continued his research in the Boris Kidritch Institute of Nuclear Science, where there were convenient facilities for carrying out his work. The premises in Novi Sad and a part of the fittings and apparatus were taken over by a newly founded bacteriological and serological laboratory under my leadership, and the whole organization was named the Medical Research Laboratory of Vojvodina. This new Laboratory has fixed research tasks, and its budget is financed by the State.

Novi Sad is a relatively small town of 86,000 inhabitants, but notwithstanding is the cultural and administrative centre of a rather large territory containing about eight hundred medical practitioners. The idea arose that scientific research work should not be the privilege of a fortunate few, exclusively employed for this purpose in well-equipped laboratories with undisturbed working possibilities; the ordinary medical practitioner often has a creative idea, and it was proposed that an organization should be established with the task of preserving creative ideas and not letting them fall into oblivion. The state of medical conditions in Yugoslavia makes it imperative that this help should be given so as to develop ideas which are in close touch with practical questions of health and sanitation.

The Laboratory has therefore been created in two parts: one is the bacteriological and serological laboratory already mentioned, with full-time workers who are allotted research tasks; and the other is the 'service laboratory', where part-time laboratory workers are employed, with the task of helping physicians who are working out their ideas in their spare time. The management of the Laboratory investigates whether the idea is original, whether it has some relations to practical sanitary questions and whether the Laboratory is able, taking into account limitations of staff and finance, to help in carrying out the research. In the service department of the Laboratory the following part-time workers are employed: a pathologist, a bacteriologist, a hæmatologist, a biochemist, and a surgeon for carrying out operations on experimental animals. Besides these, the Laboratory employs assistants for part-time work according to the necessity and nature of the work. The above-mentioned sections are in the process of being formed and are at present only very modestly equipped; among other things, it is very difficult to get hold of medical publications and the periodical literature. It might be thought that, under such conditions, it is a mistake to undertake such a job and that it would be better to wait until matters improve. But to do so would be to risk losing ideas and losing the collaboration of ambitious young workers, and this would be an even greater mistake; so we have decided to work under the present conditions, even at the risk of publishing something in ignorance of the fact that the same work has been published elsewhere by others.

The Laboratory has proved to be an active organization, for since the time of its functioning in 1951 eight research workers have asked for help from its laboratory service and have worked on the following topics, publishing them in the Yugoslav medical press and also partly in foreign periodicals: the mechanism of blood clot retraction[2]; the determination of the value of the thrombocytes with regard to their function in blood clot retraction[3]; the determination of the serum protein fractions with the aid of salting out with ammonium sulphate[4]; the fractionation of beef heart extract[5]; new methods of making serial dilutions with small gradations[6]; new methods for adjusting colloidal gold solutions and carrying out the colloidal gold test[7]; the nature of the process of fibrinolysis and the products of the decomposition of the fibrin[8]; serum proteins in pregnant women[9]; the estimation of blood plasma clotting and the relation of the calcium concentration to the first and the second phase of blood coagulation[10]; the therapy of miscarriage with histamine[11]; the finding of enhanced sensitivity of some *Salmonella* strains to bismuth and the prescription of a modification of the Wilson–Blair medium for the elimination of the inhibitory power of bismuth (balanced sulphite agar)[12]; experimental hyperfolliculinemy in dogs[14]; and experimental eclampsia in dogs[15]. Nearly all the papers enumerated in refs. 2–15 are written in Yugoslavian, but a translation or detailed summary will gladly be sent if requested. Besides these published papers, the following research problems have been registered at the Laboratory and are still under investigation: the disturbances of the antihæmorrhagic mechanism in dogs injured by X-rays; the nature of the *S* factor of blood clot retraction; contribution to the pathogenesis of eclampsia; the investigation of the effect of the liver on œstrogen metabolism; the changes arising in the antihæmorrhagic mechanism caused by folliculin; the effect of cation combinations of the sulphite-reducing micro-organism; experiments on the quantitative estimation of the accessory growth factor; the effect of artificial hibernation on the incubation of some virus diseases.

The full-time part of the Laboratory has worked out experimentally the possibility of preparing desiccated culture media and has prepared an extract for the Meinicke clarification test. As a result of these investigations, the Laboratory has prepared a rather good desiccated Wilson–Blair agar on a small scale and, in addition, has furnished most of the *M*-antigen used in Yugoslavia.

I do not know whether such an organization exists elsewhere, and I should be very grateful for any relevant information. If this form of a research organization is a new one, its existence could, in my opinion, be explained by the special conditions of medicine prevailing in Yugoslavia: on one hand, by the great demand for medical aid, which means that medical practitioners are very much preoccupied by routine medical work, and, on the other, by their desire for extending their medical knowledge. This overtime work has proved a great stimulus, and furthered their interest in their profession.

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THE BRITISH GELATINE AND GLUE RESEARCH ASSOCIATION

RESEARCH PANEL MEETING

THE ninth meeting of the Research Panel of the British Gelatine and Glue Research Association was held on December 9. Mr. S. G. Hudson (Messrs. Richard Hodgson and Sons, Ltd.) was in the chair. Three papers were presented, each being concerned with a major item of the research programme of the Association.

Dr. J. E. Eastoe in his paper, "Gelatin as a Chemical Compound", described the stages which must be followed in elucidating the chemical structure of proteins. These include elemental analysis, amino-acid analysis, determination of amino-acid sequence, and also those aspects of the configuration of the intact protein, apart from sequence, which are affected by hydrolytic conditions. The second of the stages was the basis of the work which was being reported. The experimental method used was the chromatographic technique of Moore and Stein, using the ion exchange resin 'Dowex 50'[1], carried out almost exactly in accord with the original paper. This enabled all but one of the amino-acids present in gelatin or collagen to be estimated by means of two chromatographic experiments, one using a long column of resin, and a second run in which a short column was used for the estimation of the basic amino-acids. These are not given accurately with the long column. The remaining acid to be estimated, hydroxyproline, was determined by the colorimetric method of Neuman and Logan[2] in preference to carrying out a third chromatographic separation.

The method of analysis has been applied to a selection of gelatins and collagens of mammalian origin, and is also being extended to fish materials. The general conclusions were that the results as a whole showed very satisfactory agreement with the determinations, by a number of methods, for gelatin by Chibnall and co-workers[3,4], and for collagen[3–5], for which Bowes and Kenten had also carried out careful analyses. The results for the whole range of materials also agreed well with the microbiological determinations of Neuman[6]. The differences between the results for all the mammalian gelatins and collagens studied, with the exception of the content of amide nitrogen, and the ratio ornithine/arginine, were generally so small that they might result from small quantities of impurities. The two exceptions arise not from differences in the native tissues, but from the effect of manufacturing processes. The differences between mammalian and fish collagens, particularly in regard to the hydroxy amino-acids, confirm previous results[6].

Dr. A. W. Kenchington in his paper, "Gelatin Derivatives and their Properties", said that he had attempted to modify in turn all the more important polar groups of the gelatin molecule. The behaviour of methylated gelatins, in which the carboxyl groups have been esterified with methanol in the presence of hydrochloric acid, had already been reported[7]. The amino-groups were acetylated using acetic anhydride in the presence of sodium acetate. The comparison of the degree of substitution, estimated by acetyl determination, and by measurement of the number of unreacted amino-groups by the titration curve method[8], showed that at low degrees of substitution only the amino-groups had reacted. At higher degrees of substitution there was evidence of acetylation of hydroxyl groups also.

The number of guanidino-groups of gelatin was increased by means of the reaction between the amino-groups and *o*-methyl isourea. Almost quantitative reaction was produced, as shown by the technique of Moore and Stein[9], the lysine and hydroxylysine residues becoming homoarginine and hydroxyhomoarginine respectively. Removal of the guanidino-groups by means of alkaline hypobromite, although effective for this purpose, also caused some degradation of the polypeptide chain.

Mr. P. R. Saunders, in a paper on "Degraded Gelatins: their Properties and Structure", described the effect of degradation in solution brought about by heat, extremes of *p*H, ultrasonics, and hydrogen peroxide. The physical properties of the degraded gelatins which were measured included viscosity in both concentrated and dilute solutions, and gel rigidity over a range of temperatures from 0° C. to near the melting point. It has been established by this work that degradation can both reduce the mean molecular weight of the gelatin and also destroy to a greater or less extent an intrinsic power of gelling. This point has been verified by fractionation of the degraded gelatins according to molecular weight.

A general discussion on the gelling of gelatin was opened by Mr. A. G. Ward, director of research of the Association.

A. G. WARD

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STATISTICS OF WINDFALLS AND DISASTERS

AN admirable little book, on the "Statistical Theory of Extreme Values and Some Practical Applications"*, presented in a vigorous and attractive style by one who has contributed extensively to the subject, has been written by E. J. Gumbel and published by the United States National Bureau of Standards in its Applied Mathematics Series. Suppose we have n independent observations $x_1, x_2, \ldots, x_n$, with a common distribution-function

$$F(t) \equiv \text{prob}\,\{x \leqslant t\}.$$

Then, if $y_1, y_2, \ldots, y_n$ are the same n observed numbers re-arranged in descending order of magnitude, the largest value y_1, the smallest value y_n and the range $y_1 - y_n$ are three new random variables the joint distribution of which will depend on the distribution-function F with which we started. It is usual in statistical problems to have to make simplifying assumptions about the initial distribution before progress is possible. In the history of the theory of extreme values we see an interesting reversal of this general rule; the characteristic features of the theory as it exists to-day did not emerge until special assumptions about the initial distribution (for example, that it was 'normal') were abandoned and instead attention was concentrated on whole classes of initial distributions giving rise to a common asymptotic behaviour of the distribution of y_1. The work of Fréchet in 1927 and of Fisher and Tippett in the following year revealed three forms of asymptotic behaviour for the distribution of y_1, when n is large, each being associated with a different class of initial distributions. The assignment of a distribution to the correct class depends on the behaviour of $F(x)$ for large positive x and so not on the features of the initial distribution which normally strike one as the most important. For example, the negative-exponential distribution,

$$F(x) = 1 - \exp(-x) \quad (x \geqslant 0), \qquad (1)$$

and the 'normal' distribution,

$$F(x) = \frac{1}{\sqrt{(2\pi)}} \int_{-\infty}^{x} \exp(-\tfrac{1}{2}t^2)\,dt \quad (-\infty < x < \infty), \qquad (2)$$

belong to the same class. If we restrict attention to (1), we can easily obtain a selection of results illustrating the general theory.

Let y be the largest value in a sample of size n, ($F(x)$ being given by (1)), and let $y = z + \log n$. Then

$$G(u) \equiv \text{prob}\,\{y \leqslant u\} = \text{prob}\,\{\text{all } x_i \leqslant u\} = [1 - \exp(-u)]^n,$$

and

$$H(v) = \text{prob}\,(z \leqslant v) = G(v + \log n) = \{1 - \frac{1}{n}\exp(-v)\}^n$$

$$\to \exp\{-\exp(-v)\} \text{ as } n \to \infty.$$

Thus for the reduced largest value z we obtain the asymptotic distribution,

$$\exp[-\{z + \exp(-z)\}]\,dz \quad (-\infty < z < \infty), \qquad (3)$$

valid when n is large. The distribution (3) has zero mode, a mean of $\gamma = 0{\cdot}577$ (Euler's constant) and a standard deviation of $\pi/\sqrt{6}$. Analogous results hold when the initial distribution is of the 'normal' form; it is only the method of reducing the variable which must be altered.

The fact that

$$E\,\{\text{largest value}\} \simeq 0{\cdot}577 + \log n \qquad (4)$$

for the distribution (1) (other distributions in the same class giving rise to similar formulæ) explains an empirical law discovered by W. E. Fuller: the size of the largest flood increases linearly with the logarithm of the period of observation.

This brings us to the applications. It will be obvious how a careful use of the theory supplies a rational approach to the old problem of 'the rejection of outlying observations'; but more interesting are the situations in which the extreme values are themselves the principal objects of study, instead of being merely awkward facts which one would like to ignore. Two such situations will be mentioned here; they are selected from many. A flood is defined in the present context as the largest daily discharge of a given river in a given year. It is thus the largest value in a sample of size $n = 365$ (or 366) members. The lack of independence between daily discharges may, to a first approximation, be allowed for by assuming the weekly floods to be independent, so that $n = 52$. The effect of seasonal variations is less obvious, but the use of distributions such as (3) to describe the observed annual floods of rivers like the Mississippi has proved very successful and has been found of great value in dam design. A second application of particular interest is one which is currently being made to the study of the breaking-strengths of materials. ("No chain is stronger than its weakest link".) In general, this work should interest all those who are concerned with the application of this sort of statistics to such problems as the breakdown of capacitors, the breaking strength of yarn, extinction times for bacteria, gust velocities in thunderstorms, the vagaries of the climate (and the stock market) and the occurrence of centenarians.

David G. Kendall

* United States National Bureau of Standards, Applied Mathematics Series No. 3: Statistical Theory of Extreme Values and Some Practical Applications—A Series of Lectures. By E. J. Gumbel, with the assistance of Julius Lieblein. Pp. viii+51. (Washington, D.C.: Government Printing Office, 1954.) 40 cents.

INSTITUTE OF HIGH-SPEED MECHANICS, TÔHOKU UNIVERSITY

THE Institute of High-speed Mechanics, Tôhoku University, which was established in October 1943 under the directorship of Prof. F. Numachi, grew out of the Faculty of Engineering of the University, in which considerable achievements in the study of cavitation phenomena had already been attained. The Institute consisted initially of two research branches dealing with cavitation phenomena, and with engines and instruments, respectively. In January 1945 four additional branches were established; but at the end of the Second World War the branch dealing with thermal fluid-dynamics related

to aero-engines was closed down and the Institute now consists of five research branches with a senior scientific staff of five professors and five assistant professors.

In the latest issue of the Reports of the Institute of High-speed Mechanics (5, No. 41; 1954) a descriptive report of the historical development and of the present research activities is given, together with details of the personnel and government of the Institute. Most of the original buildings, with the exception of the workshop and underground water tank of the hydraulic laboratory, were destroyed during air raids; but reconstruction was commenced after the War and the main Institute building, together with a three-story reinforced concrete building with floor area of 10,670 sq. ft. and a connecting building of 2,670 sq. ft., have been erected. These buildings house the heat, air, fatigue and vibration laboratories in addition to the administrative and workshop facilities.

The names of the various members of staff together with their subjects of research are listed in the report and details of the available research and workshop equipment are given. The research topics are mainly concerned with cavitation tests on hydrofoil profiles, high-speed water turbines and axial flow pumps. Recent work on gas turbines is to be extended, and it is hoped to revive the research branch on thermal fluid-dynamics. An impressive list of the titles of the scientific articles published by members of the staff of the Institute since 1949 and included in the report bears evidence of the steadily worthwhile results obtained both in the academic and applied fields of research at the Institute.

S. WEINTROUB

SOURCES OF GERMANIUM IN GREAT BRITAIN

By R. H. A. CRAWLEY

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GERMANIUM is an element of increasing interest, particularly for the manufacture of a variety of semiconductor devices by the electrical industry. At the present time, germanium in Great Britain is obtained almost exclusively from gas-works flue dusts[1]. Most British coals, except those from South Wales, contain small amounts of germanium[2], and we have therefore considered the possibility that useful concentrations of germanium might be found in the industrial plants of other large coal users.

Samples from the British Electricity Authority. The British Electricity Authority is the largest single user of coal in Britain. We believe that analyses have been made by other workers of deposits and flue dusts from various plants of the Authority; but few results have so far been published. We have examined many samples of deposits and flue dusts and some typical results are shown in Table 1. The method of examination used was, with minor modifications, that described by Cluley[3].

It will be seen that a number of the superheater and economizer deposits show an appreciable concentration of germanium; but the flue dusts show only low concentrations. The quantities of enriched deposits available vary widely from plant to plant,

Table 1. GERMANIUM CONTENT OF POWER PLANT RESIDUES

Source	Description	Germanium (per cent)
Northampton (East Midlands Division)	Economizer deposit	0·12
	Superheater deposit	0·05
	Deposit on last row of boiler tubes	0·14
Spondon (East Midlands Division)	Fly ash from bottom generator bank	0·014
	Bonded deposit from bottom generator bank	0·13
	Deposit on superheater tubes	0·09
	Deposit on upper generator bank	0·22
	Deposit on upper generator bank (different position)	0·28
	Deposit on economizer tubes (top)	0·14
	Deposit on economizer tubes (bottom)	0·05
Bolton (N.W. Division)	Deposit on bottom bank of generator tubes	0·025
	Deposit on bottom row of superheater tubes	0·09
	Economizer deposit	0·05
Trafford Park (N.W. Division)	Generator deposit	0·03
	Economizer deposit	0·06
	Superheater deposit	0·065
Halifax (Yorkshire Division)	Flue dust at chimney base	0·012
	Flue dust—air heater hoppers	0·005
	I.D. fan grit collectors	0·005
Bradford (Yorkshire Division)	Cyclone grits	nil
	Economizer grits	0·005

and, moreover, it is not always possible because of the structure of the plant to recover all the deposit potentially available. Nevertheless, this source of germanium should repay further investigation.

Gas Works Tar. Although the largest concentration of germanium in gas works is found in the flue deposits of the producer-gas plant, we thought it worth while to examine the possibility of recovering germanium from tar or liquor, particularly in view of a report from Japan that a process has been developed there for recovering germanium from gas-works liquor. With the co-operation of the Midland Tar Distillers, we examined a sample of tar which was representative of tar obtained from a number of gas works in the Midlands; it was found to contain 3–4 parts per million of germanium. Also with the co-operation of the Midland Tar Distillers, we have examined the source of the germanium during tar distillation, with the results shown in Table 2. The method of examination again follows that described by Cluley, except that the tar is first ignited at 450° in air to remove the bulk of the organic matter. If 450° is not exceeded, it has been shown that no germanium is lost by volatilization.

It is evident that the germanium is entirely retained in the pitch fraction. Now the pitch normally contains about 0·2–0·5 per cent of ash, so that taking a figure of 10 parts per million of germanium in the pitch and assuming that all this would be retained in the ash, one might expect a germanium content in the ash of about 0·2–0·5 per cent.

A considerable quantity of pitch is burned as fuel, and we have therefore examined several flue dusts from a number of pitch-burning plants. Typical

Table 2. TAR DISTILLATION: DISTRIBUTION OF GERMANIUM

Crude tar, before distillation		3·4 p.p.m.
Distillate fraction	No. 1: Up to 210° C.	Nil
	No. 2: 210°–250° C.	Nil
	No. 3: 250°–300° C.	Nil
	No. 4: 300°–350° C. (approx.)	Nil
Pitch:	Sample No. 1 (continuous distillation)	11·5 p.p.m.
	No. 2 "	7·8 p.p.m.
	No. 3 (pot still pitch)	6·4 p.p.m.
Residue in pre-flash column		Nil
Residue at base of fractionating column		Nil

Table 3. Germanium Contents for Residues from Pitch-burning Plants

The Midland Tar Distillers :	
Flue dust from Babcock boiler	0·045 (high carbon content)
Firm using the Midland Tar Distillers fuel :	
Flue dust from pitch-creosote burning plant	0·15
Dorman Long :	
Flue dust—back flue	0·28
,, front flue	0·24
Boiler flue dust	0·21
Economizer flue dust	0·10

results are shown in Table 3, and the germanium contents are of the order expected. It is evident that these dusts constitute a potentially valuable source of germanium.

Other Coal-using Industries. Steel works consume large quantities of coal, and in a private communication from Mr. C. C. Gegg, of Thomas Firth and John Brown, Ltd., useful concentrates of germanium (up to 0·4 per cent) have been reported in flue dusts. A smaller quantity of coal is burned in the glass industry, and in this case we have found germanium in quantities up to 0·3 per cent in the flue dusts. Unfortunately, it appears that the amount of germanium-rich dust available from the latter source is negligibly small.

Acknowledgment is due to the British Electricity Authority, the Midland Tar Distillers, Thomas Firth and John Brown, Ltd., and Dorman Long and Co., Ltd., for their co-operation in this investigation ; to Mr. J. E. Stanworth and Mr. J. V. Hardwick for helpful discussion ; and to Mr. L. J. Davies, director of research, British Thomson-Houston Co., Ltd., for permission to publish this communication.

[Sept. 24.

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NITRIFYING ORGANISMS IN GLASSHOUSE SOILS

By Dr. R. KLEIN

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IN the course of investigations on the problem of nitrification in steam-sterilized glasshouse soil, suggested by Dr. W. F. Bewley, director of the Experimental and Research Station, Cheshunt, it was considered necessary to study the activity of the nitrifying organisms in pure culture and the possibilities of their improvement in pure and mixed (crude) cultures before trying to reconstitute the association soil + nitrifiers. Since it was not possible to obtain pure cultures from sources in Britain or abroad, the isolation of these organisms had to be attempted as the first step in this work.

The preliminary work comprised among other experiments the separation of *Nitrosomonas* and *Nitrobacter*, the use of silica gel plates which can be prepared without the tedious process of dialysing, the inoculation of these plates by streaking (according to various writers silica plates cannot be inoculated by streaking because water oozes out into the streaks), the use of antibiotics for purification of the nitrifiers, and the maintenance of the pure and the crude cultures under mineral oil ; it is not yet known whether the presence of other soil bacteria has an effect on the nitrification in the soil, and it might be necessary to use crude cultures for the above-mentioned reconstitution.

The present account is concerned with only one part of this work. Although Winogradsky[1] mentioned that Boullanger and Massol[2] tried various ammonium compounds instead of ammonium sulphate and found that ammonium borate gave good nitritation, he kept to the use of the sulphate in the medium for *Nitrosomonas*, and this medium has been used as a standard medium, sometimes with minor modifications, by all workers in this field. I had experienced the favourable effect of borates in microbiological work of a different type and was, therefore, interested to find out how the nitrifiers would react to them.

The cultures used were *Nitrosomonas* sp. and *Nitrobacter* sp. isolated from glasshouse soil, separated and partly purified. The first experiments of this kind were made with F_{10}, and subcultures in 1-in. boiling-tubes were used to save incubator space. These boiling-tubes were kept in wire baskets in a sloping position to reduce the depth and enlarge the surface of the liquid medium.

In the work with *Nitrosomonas*, ammonium sulphate in Winogradsky's medium was replaced by ammonium borate, keeping the nitrogen contents at about the same level. No attempt was made to determine the optimum amount of ammonium borate, and owing to the limited incubator space some experiments had to be carried out at 25° C. instead of 30° C. The different temperatures probably require different amounts of ammonium borate. The cultures were tested on spotting plates, with Nessler's reagent for ammonia and with Trommsdorf's reagent for nitrite.

The experiments were repeated several times, always with three different series of cultures, which apparently represented three different strains, and set up in duplicate. A typical example is shown in Table 1.

Table 1 shows clearly that, under the conditions of the experiment, the ammonia disappeared more rapidly and the nitrite was formed more quickly in the cultures with ammonium borate. Since only spot tests were used for examining the course of the nitritation and no quantitative determinations were made, it is not possible to say whether the whole of the ammonia was oxidized to nitrite. The colour tests give only a relative picture, and their evaluation depends on my personal impression. Yet from the numerous tests, I believe that the appearance and increase of the nitrite in the ammonium borate cultures were sometimes slower than the disappearance of the ammonia, that is, there is a much greater difference between sulphate and borate cultures as regards disappearance of ammonia than as regards appearance of nitrite. It is possible that the degree of contamination has an effect, and some organisms other than *Nitrosomonas* might use up part of the ammonia in the borate cultures more quickly than in the sulphate cultures. Whether this is the case can only be found out by comparison of the activities of *Nitrosomonas* in mixed cultures and in pure cultures.

It was probably the metabolic activity of the accompanying soil bacteria that caused the discrepancy in a series of experiments with soils from Littlehampton. Three soils were used : a field-soil (*L/FS*), a manured (*L/B*), and a manured and

Table 1. NITRITATION IN MEDIA CONTAINING AMMONIUM SULPHATE AND AMMONIUM BORATE, RESPECTIVELY, BY THREE STRAINS OF *Nitrosomonas* sp./$F_{7\,6}$

Strain	Source of ammonia	2 days		4 days		5 days		6 days		7 days		11 days	
		NR	TR	NR	TR	NR	TR	NR	TR	NR	TR	NR	TR
C/A	sulphate	+++(+)	+(+)	++(+)	++(+)	++	+++	+	++++	+	5	—	6
	borate	++	++	+(+)	+++	∓	++++(+)	—	5½	—	6	—	6
C/B	sulphate	+++(+)	++	+++	++(+)	++	++(+)	+	+++(+)	+	5	—	6
	borate	++	++(+)	+	+++(+)	(+)	++++	(∓)	5	—	6	—	6
C/C	sulphate	+++(+)	+(+)	+++	++	++(+)	++	+	++(+)	(+)	5	—	6
	borate	++	+++	+	++++	+	++++(+)	∓	5	(∓)	5½	—	6

The marking is the customary one: (∓) indicates a trace of colouring; increased intensity is shown by the number of + and by figures respectively.

NR, Nessler's reagent: the strongest reaction of the medium before inoculation was marked ++++.
TR, Trommsdorf's reagent: a trace of nitrite is marked (∓), full nitritation is 6.

fertilized (*L/D*) glasshouse soil. The crude cultures were made with ammonium sulphate medium. Then transfers F_1 were made into ammonium sulphate and ammonium borate media and afterwards from sulphate cultures F_1 into sulphate medium and from borate cultures F_1 into borate medium, the two series being continued without cross-transfers from one kind of medium into the other. As regards disappearance of the ammonia, the picture was always the same. It decreased in all three series considerably more rapidly in the ammonium borate cultures. Yet as regards the formation of nitrite, the cultures from the three soils behaved differently. In the borate cultures of *L/FS*, the formation of nitrite was for some time insignificant, and was increased only when, after the disappearance of the ammonia, another dose of ammonium borate was added. But the nitrite contents never reached the same level as in the other cultures. This discrepancy might perhaps be overcome by altering the quantitative composition of the medium. In the *L/B* cultures the formation of nitrite was slower in the borate cultures than in the sulphate cultures, but reached eventually the same peak. Yet in the *L/D* cultures the formation of nitrite lagged behind in the borate cultures of F_1, but from F_2 onwards it was faster than in the sulphate cultures.

Experiments with *Nitrobacter* cultures from glasshouse soil at Cheshunt showed that this organism is very susceptible to boron, whether given as boric acid or sodium borate. It was therefore of interest to keep the *Nitrosomonas* cultures made from the Littlehampton soils, after the whole of the ammonia had been oxidized to nitrite, and to test them again after an interval. The results were quite interesting. The F_1 cultures were tested after about a month. In the ammonium sulphate cultures, the nitrite had almost completely disappeared, and diphenylamine–sulphuric acid gave strong reactions for nitrate; a few days later there was no trace of nitrite to be found. The transformation of the nitrite to nitrate had apparently commenced much earlier; the beginning, however, could not be dated, since there was a comparatively long interval between the two critical tests, the one when nitrites were at their peak and the other one when scarcely any nitrite was detectable. The ammonium borate cultures, however, with the exception of the *L/FS* cultures, gave always strong nitrite reactions, and when the experiment was concluded—the cultures were then more than two months old—they still did not show any change.

In the tests of F_2, long intervals were avoided and it was therefore possible to find that the oxidation of nitrite to nitrate in the sulphate cultures started very early. In the cultures of *L/D*, the nitrite had disappeared in less than three weeks from the inoculation date; in *L/FS* and *L/B* cultures it took a little longer. But again the ammonium borate cultures, after complete nitritation, remained unchanged, and even after seven weeks there was no decrease in the nitrite contents. As in F_1, the *L/FS* cultures with ammonium borate were here an exception, too.

Some *L/B* cultures did not show any decrease of their nitrite contents, a sign that there was no *Nitrobacter* present. It can always happen that the transfer of a mixed *Nitrosomonas–Nitrobacter* culture into a *Nitrosomonas* medium results in a *Nitrobacter*-free culture when the latter organism is weak or present only in very small numbers. Usually, however, it takes a fair number of transfers to obtain *Nitrosomonas* cultures free from *Nitrobacter*. Meiklejohn[3] still found nitrate production in the twenty-fourth successive transfer. The replacement of ammonium sulphate by ammonium borate can be used not only to achieve speedier nitritation but also to rid the *Nitrosomonas* cultures of *Nitrobacter* at an early, perhaps even at the first, transfer.

Owing to the imminent move of the Experimental and Research Station to Littlehampton, this work will have to be discontinued for the time being, and a preliminary report of it will be published elsewhere. [Nov. 25.

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POSITION AND REACTIVITY OF THE HISTIDINE RESIDUES IN CYTOCHROME *c*

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THE position of the histidine residues in the cytochrome *c* molecule has been of interest since Theorell and Åkesson[1] put forward the suggestion that the imidazole groups of two histidines are the groups co-ordinating with the iron atom of the cytochrome *c* hæm, in positions 5 and 6, thereby producing the hæmochromogen type of spectrum of the protein. These authors used a beef heart cytochrome *c* preparation containing 0·43 per cent iron. Their

evidence was that, of the three histidine residues in the molecule, only one had an imidazole group which could be titrated in the *p*H range 5·5–8·5[2], the other two being presumably co-ordinated with the hæm iron.

Paul[3] showed that, on treating beef heart cytochrome *c* with 1,2,4-fluorodinitrobenzene, only 0·47 out of the three histidines did not form dinitrophenyl derivatives, as calculated from determinations of free histidine after complete hydrolysis of the dinitrophenylprotein. The free histidine was determined using a bacterial decarboxylase which reacts with histidine only if the imidazole, α-amino and carboxyl groups are unsubstituted.

Following the purification of cytochrome *c* on columns of cation exchangers, preparations containing 0·465 per cent iron could be obtained[4,5]. With these preparations the reactivity of the histidines was re-investigated using the more direct fluorodinitrobenzene method developed by Sanger[6].

Oxidized cytochrome *c* was prepared by treating the protein in water with hydrogen peroxide, precipitating the oxidized material with ten volumes of acetone in the cold and taking it up at once in water. Histidine was determined by the Pauly reaction according to Macpherson[7], after elution from paper chromatograms developed with the butanol – formic acid solvent of Acher and Crocker[8]. Imidazole mono-dinitrophenylhistidine was synthesized according to directions kindly provided by Dr. F. Sanger. α-Acetylhistidine[9] was treated with fluorodinitrobenzene and the α-acetyl imidazole mono-dinitrophenylhistidine obtained was hydrolysed in boiling 20 per cent hydrochloric acid. The product recrystallized from acetic acid was colourless. It migrated on butanol – formic acid paper chromatograms as a well-defined spot with a faint preceding trail of material. When dry, the spot darkened gradually in the light over a period of 5–10 days. Since the imidazole ring is rather labile when substituted, it may be that in this synthetic product the ring had opened. However, since the synthetic imidazole dinitrophenylhistidine was chromatographically identical with that obtained from dinitrophenyl cytochrome *c*, it must be supposed that if the ring had opened in the synthetic material it had done so also during the procedure with the protein, thus not affecting the argument. On the other hand, since alkaline hydrolysis of the synthetic imidazole dinitrophenylhistidine yielded some free histidine showing a positive Pauly reaction[10], at least part of the original product had an intact imidazole ring. Imidazole dinitrophenylhistidine was estimated by titration with titanous chloride[11] after elution with 35 per cent acetic acid in water from butanol – formic acid chromatograms. The identity of the material obtained from dinitrophenyl cytochrome *c* was confirmed by hydrolysing it with concentrated ammonia solution in a sealed capillary tube, and identifying the free histidine produced both chromatographically and by the Pauly reaction according to Sanger and Tuppy[10].

α-Amino mono-dinitrophenylhistidine was identified as a reddish-yellow spot which gave a positive Pauly reaction and a negative ninhydrin test on butanol – formic acid paper chromatograms of hydrolysates of dinitrophenyl cytochrome *c*. On such chromatograms it had an R_F value of 0·09 as compared with 0·02 for free histidine, 0·16 for imidazole dinitrophenylhistidine and 0·63 for *bis*-dinitrophenylhistidine. Several attempts to synthesize α-dinitrophenylhistidine resulted only in mixtures containing approximately equal amounts of imidazole dinitrophenylhistidine and α-dinitrophenylhistidine. Therefore, the identity of the presumed α-dinitrophenylhistidine obtained from dinitrophenyl cytochrome *c* was confirmed indirectly. It could be shown that when the material corresponding to the presumed α-dinitrophenylhistidine on a butanol – formic acid chromatogram of a hydrolysate of dinitrophenyl cytochrome *c* was eluted and treated with an excess of fluorodinitrobenzene under the usual conditions, it was transformed into *bis*-dinitrophenylhistidine, which was identified both by paper and column chromatography as described below. α-Dinitrophenylhistidine was routinely estimated by titration with titanous chloride[11] after elution from butanol – formic acid chromatograms with 35 per cent acetic acid in water.

Bis-dinitrophenylhistidine was determined spectrophotometrically after separation from other dinitrophenyl derivatives present in the continuous ether extract of hydrolysates of dinitrophenyl cytochrome *c*, on an ammonia-activated kieselguhr column according to Mills[12]. Its concentration in this continuous ether extract could also be calculated from the optical density of the extract at four selected wave-lengths (240, 290, 320 and 350 mμ), taking into account the extinction at these wave-lengths of the only four compounds in the extract, namely, *bis*-dinitrophenylhistidine, dinitroaniline, dinitrophenol and traces of ε-amino mono-dinitrophenyllysine. The four equations with four unknowns obtained could be solved for the concentration of any one of the compounds desired. The identity of the *bis*-dinitrophenylhistidine was further verified on paper chromatograms developed with tertiary amyl alcohol saturated with phthalate buffer *p*H 6, according to Blackburn and Lowther[13].

All results were calculated as moles per mole of cytochrome *c* iron, as determined spectrophotometrically and also directly by the dipyridyl method according to Keilin and Hartree[14]. The results were corrected for the destruction of the dinitrophenyl amino-acids during hydrolysis in the presence of cytochrome *c*.

Using a chromatographic fraction I[5] of horse heart cytochrome *c* containing 0·465 per cent iron (native, fully enzymically active protein) and carrying out the reaction with fluorodinitrobenzene in 66 per cent ethanol[6] for relatively short periods, the histidines were recovered as follows: 1 mole of *bis*-dinitrophenylhistidine, 1 mole of imidazole dinitrophenylhistidine, and somewhat less than 2 moles of free histidine. Determinations of histidine following hydrolysis of the original preparation of cytochrome *c* confirmed that horse heart cytochrome *c* contains four moles of histidine per mole of iron, rather than the three moles found in the beef heart preparation[1]. When the reaction with fluorodinitrobenzene in 66 per cent ethanol was continued for relatively long periods, there was a gradual disappearance of one of the histidine residues, which had previously been recovered as free histidine. This residue could then be accounted for as α-dinitrophenylhistidine. The second histidine residue, which was usually recovered as free histidine, could not be made to react even after prolonged periods of contact with fluorodinitrobenzene in 66 per cent ethanol under the usual conditions. When oxidized cytochrome *c* was used, nearly 2 moles of *bis*-dinitrophenylhistidine, 1 mole of imidazole dinitrophenylhistidine,

Table 1

Cytochrome *c* preparation	Reaction with FDNB Medium	Time (hr.)	Moles/mole of cytochrome *c* iron Histidine	Im. DNP histidine	α-DNP histidine	*Bis*-DNP histidine	ε-DNP lysine
Fraction I	—	—	4·05	—	—	—	—
Dinitrophenyl fraction I	Water	4	1·88	1·00	0·11	0·81	13·8
Dinitrophenyl fraction II	66 per cent ethanol	1	1·69	0·90	0·38	1·13	21·1
Dinitrophenyl fraction II	66 per cent ethanol	6	0·97	1·09	0·99	1·08	19·6
Dinitrophenyl fraction II	66 per cent ethanol	24	0·96	1·01	0·91	0·93	20·0
Dinitrophenyl oxidized cytochrome *c*	66 per cent ethanol	24	1·01	0·92	0·26	1·86	16·7

1 mole of free histidine and very little α-dinitrophenylhistidine were recovered.

In conclusion, it can be stated that one histidine residue is a normal amino end-group of cytochrome *c*, another histidine has a normally reactive imidazole group, while the last two histidine residues have unreactive imidazole groups. One of the latter histidines has a slowly reacting α-amino group and an imidazole group which reacts only after the protein is oxidized. Thus it represents an amino end-group of the protein with an attached imidazole group, the latter being liberated only after a drastic treatment which, together with other effects, destroys the cytochrome *c* hæm. The second unreactive histidine could not be made to react at all under any of these conditions.

Ethanol in the same concentration and under the same conditions as usually used for the reaction of fluorodinitrobenzene with proteins was found to transform fraction I cytochrome *c* into a product which had the same chromatographic characteristics on columns of 'Amberlite *IRC*-50' as the fraction II present in preparations of horse heart cytochrome *c* (compare with ref. 5), and, like it, was spectroscopically identical with fraction I but enzymically inactive. This alcohol-modified cytochrome *c* will therefore be referred to as fraction II. When the reaction of fraction I cytochrome *c* with fluorodinitrobenzene was carried out in water, thus preventing the transformation into fraction II, the distribution of the histidines into the various dinitrophenyl derivatives was the same as that shown by the dinitrophenyl fraction II obtained from reactions with fluorodinitrobenzene in 66 per cent ethanol for short periods.

Fraction II, moreover, appears to be an 'unfolded' or 'denatured' form of the native fraction I, as evidenced by the fact that with fraction II nearly all the twenty-two lysine residues present in the cytochrome *c* molecule react with fluorodinitrobenzene, whereas only fourteen can bind this reagent when fraction I is maintained in its original form during the reaction. A typical series of results is given in Table 1.

These results are in good accord with those obtained by Theorell and Åkesson[1] and Paul[3] with beef heart cytochrome *c*. Since in horse heart cytochrome *c* there are two histidine residues the imidazole groups of which are unavailable for reaction with fluorodinitrobenzene both in the folded native protein (fraction I) and the spectroscopically identical but unfolded enzymically inactive molecule (fraction II)[5], these groups are presumably already occupied, and possibly co-ordinated with the hæm iron.

Paul's recovery of only 0·47 mole as free histidine out of the original 3 moles in beef heart cytochrome *c* treated for two hours with fluorodinitrobenzene in the presence of ethanol[3] probably indicates that the third histidine, which had only partially reacted with fluorodinitrobenzene, corresponds to the one in horse heart cytochrome *c* which has an unreactive imidazole group but a slowly reacting α-amino group (see Table 1). If this analogy is correct, and we assume further that the second hæmochromogen-forming group in horse heart cytochrome *c* is not one of the other two histidines reacting with fluorodinitrobenzene, in beef heart cytochrome *c* the second hæmochromogen-forming group is therefore probably not a histidine. This conclusion is similar to that arrived at by Paul as a result of his titration experiments[3].

It should be further noted that the one mole of *bis*-dinitrophenylhistidine and the one mole of α-dinitrophenylhistidine were the only end-groups so far observed with the fluorodinitrobenzene technique, thus suggesting that the cytochrome *c* molecule is built up of two peptide chains. In contradistinction to this, Theorell and Åkesson[1] calculated that beef heart cytochrome *c* contains nine to ten free amino-groups; they took the difference between the number of groups taking part in the Van Slyke nitrous acid reaction and the number of lysine residues found by analysis. Unless there is a profound difference in the proteins of beef and horse heart cytochrome *c*, this discrepancy is even larger than the large differences commonly noted with other proteins between the number of amino end-groups actually determined, as by the fluorodinitrobenzene technique, and the number calculated from the difference between the total free amino-nitrogen and that of the lysine residues. In the case of cytochrome *c*, this difference may have been increased by acidic peptides and amino-acids containing no lysine, bound electrostatically to the strongly basic cytochrome *c* protein[1] in the electrophoretically purified preparations of Theorell and Åkesson. These preparations contained 0·43 per cent iron, whereas those used in the present work contained 0·465 per cent iron, corresponding to a difference in equivalent weight of slightly more than 1,000, or some eight amino-acids.

I am grateful to Dr. K. Bailey and Dr. F. Sanger for instruction in the use of the fluorodinitrobenzene technique, and for their constant help in this work.

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LETTERS TO THE EDITORS

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The Sun's Magnetic Field and Corpuscular Emission

A NEW instrument, the solar magnetograph[1], has been developed for measuring and recording weak photospheric magnetic fields. With it, more than 450 magnetograms showing the distribution, intensity and polarity of weak fields (greater than 0·3 gauss) on the sun have been obtained over a two-year period including the recent minimum of solar activity[2]. Most of the large-scale features of the magnetic pattern show a certain regularity; but there are pronounced random variations. There is also a partially resolved fluctuating fine structure showing changes of the order of 0·5 gauss in 30 min.

General Magnetic Field. Consistent evidence has been found for a dipolar component opposite in polarity to the field of the earth. The mean intensity near the poles is of the order of 1 gauss. This field is usually limited to heliographic latitudes greater than about $\pm$ 55°; it has a varying fine structure and shows remarkable random fluctuations in effective intensity and extent. There seems to be no prevailing obliquity between the magnetic and rotational axes. The total flux is estimated to be nearly 10^{23} maxwells.

Bipolar Magnetic Regions. In the lower latitudes the stronger magnetic effects appear rather abruptly as contiguous areas of opposite polarity, as if loops of a submerged toroidal field were occasionally brought to the surface[3]. The bipolar magnetic regions obey Hale's laws of sunspot polarity[4]; but spots are comparatively rare, occurring when at all within such regions while they are young and active. Ca II *plages* are observed where the mean field intensity is greater than about 2 gauss. Hydrogen filaments occur around the borders of bipolar magnetic regions, or, alternatively, seem to divide the region into parts of opposite polarity. As the regions age, they generally expand, showing a decrease in field intensity, and disintegrate until lost in the background of irregular weak fields. There is much diversity in total magnetic flux, duration, area, and course of development.

Unipolar Magnetic Regions. Occasional extended areas of only one outstanding polarity were recognized on the magnetograms, but in no other way. The most prominent unipolar magnetic region of 1953 had a mean intensity of about 0·5 gauss and a duration of nine months or more; on each solar rotation its central passage on the disk preceded by about three days the onset of terrestrial magnetic storms in a prominent 27-day sequence. Unipolar magnetic regions may be remnants of disintegrating bipolar magnetic regions from which the lines of force have diffused outward through the corona. We suggest tentatively that unipolar magnetic regions may be identified with the hitherto hypothetical *M* regions of Bartels[5].

The observations provide objective evidence that magnetic fields are fundamental to sunspots, *plages*, prominences, chromospheric fine structure, bright coronal emissions, regions of strong radio emission and, perhaps, *M* regions. Several solar phenomena can be synthesized on the hypothesis that neutral streams of ions and electrons are being ejected more or less continually from all turbulent regions of the surface characterized by coherent magnetic fields of mean intensity 0·5 gauss or more. This corpuscular ejection is supposed to be associated with spicule activity, and to result in the acceleration of tenuous streams, individually intermittent, to velocities of some hundreds of kilometres a second in the upper chromosphere and the corona. Above the photosphere the ejected streams are guided by the magnetic lines of force over the bipolar, unipolar, or polar region, as the case may be. The streams above the spicules are composed largely of ionized hydrogen and hence are invisible except in so far as they excite the coronal radiations of the arches, rays and plumes outlining the lines of force. Corpuscular streams ascending both sides of the 'magnetic arches' above a bipolar magnetic region collide near the top, generating radio noise[6], and condense, forming visible prominences. With the emission of radio energy the material cools, the hydrogen becomes partly neutral, and the prominence begins a possibly lengthy but precarious existence under the combined influence of growth, gravity and magnetic forces. Finally, the material largely slides back down the magnetic lines of force or may be thrown outward by expansion of the arches. Above unipolar regions the streams move outward diffusely and more or less radially from the sun[7], without pronounced collisions, and hence are not generators of strong radio noise; if they interfere with the earth, they cause *M*-region phenomena. From the polar regions, where spicule activity is pronounced, corpuscular streams may recede to considerable distances. Much of the material may arrive in the vicinity of the equatorial plane, where the magnetic field is doubtless highly irregular. Through magnetic coupling, such material may carry away from high heliographic latitudes a share of angular momentum that is large in proportion to its mass.

A tentative model for corpuscular ejection involves local concentrations of the coherent magnetic field by random turbulent processes in the photosphere. Occasional attainment of equipartition of energy results in formation of concentric tubes of magnetic force of intensity $\sim$ 500 gauss. Travelling hydromagnetic waves in the form of constrictions in the tubes of force are supposed to move upward with velocity $H/\sqrt{4\pi\rho}$. Owing to the decrease of density, ρ, by a factor 10^6 in less than 10,000 km., velocities of several hundred kilometres a second may be expected in the high chromosphere if H decreases moderately. Small tenuous clouds of ions and electrons are supposed to be squeezed up the magnetic tubes ahead of the constrictions at the wave velocity. H. Alfvén[8] has considered heating of the corona by hydromagnetic waves; we extend this idea with the concept of constrictive waves in magnetic tubes of force.

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Non-Linear Plasma Oscillations and Bursts of Solar Radio Emission

WILD and co-workers[1] have reported observing a fundamental and its second harmonic in the radio spectrum of some solar disturbances. Three characteristic features of the observations are: (i) the frequency bands drift towards the lower frequencies with time; (ii) the received intensities of the fundamental and second harmonic are similar; (iii) the harmonic peak usually occurs at slightly less than twice the frequency of the fundamental peak.

Because of their frequency drift, these bursts of radiation have been associated with the outward travel of streams of particles in the solar atmosphere. Inferred velocities range from several hundred to 10^3 km./sec. Such streams of particles could supply the energy of the most intense radio disturbances.

The observed intensity and frequency ratios have been explained by Wild *et al.* in terms of propagation characteristics of the solar atmosphere. In doing so it was found necessary to assume that the fundamental emission occurs at, or near, the plasma frequency. This points strongly to the origin of the radiation in plasma oscillations. The presence of the second harmonic implies a non-linear oscillator and suggests longitudinal plasma oscillations.

It is the purpose of this communication to show that exact travelling-wave solutions, rich in even harmonics, can be obtained for non-linear plasma oscillations.

The case investigated here is that of longitudinal electron oscillations in a plasma stream. Effects of temperature and magnetic field are neglected.

Let v and n be the electron velocity and density; v_0 and n_0 those of the positive ions in the plasma; E the electric field; ω the angular wave frequency, and ω_0 the angular plasma frequency given by $\omega_0^2 = 4\pi e^2 n_0/m$, $-e$ and m being the electron charge and mass. If the two independent variables, t and x, occur only in the combination $\omega t - kx$, the equations describing the plasma are (in e.s.u.):

$$\text{equation of motion}: \quad v'(\omega - kv) = -\frac{e}{m}E, \tag{1}$$

$$\text{equation of continuity}: \quad n'(\omega - kv) - knv' = 0, \tag{2}$$

$$\text{and Poisson's equation}: \quad n - n_0 = \frac{k}{4\pi e}E'. \tag{3}$$

The prime denotes differentiation with respect to $\omega t - kx$.

Similar equations have been solved by Akhiezer and Lubarskii[2], but their solutions do not seem to satisfy Poisson's equation.

Write $$u = v - v_0. \tag{4}$$

Assuming that the electron d.c. current density equals that of the positive ions, $n_0 e v_0$, an exact set of solutions of equations (1)–(3) are:

$$\omega = \omega_0 + kv_0, \tag{5}$$

$$\omega t - kx = (l + \tfrac{1}{2})\pi + (-1)^l \frac{u_{\max.}}{\omega_0/k}\sqrt{1-(u/u_{\max.})^2} + (-1)^l \sin^{-1}(u/u_{\max.}), \tag{6}$$

where $l = 0, \pm 2, \pm 4, \ldots$ applies where u' is positive, and $l = \pm 1, \pm 3, \pm 5, \ldots$ where u' is negative. The origin, $\omega t - kx = 0$, has been placed at $l = 0$, $u/u_{\max.} = -1$.

The electron density and electric field are given in terms of the electron velocity by:

$$\frac{n}{n_0} = \frac{1}{1 - \dfrac{u}{\omega_0/k}} \tag{7}$$

and

$$\frac{E}{E_{\max.}} = (-1)^{(l+1)} \frac{u_{\max.}}{\omega_0/k}\sqrt{1-(u/u_{\max.})^2} \tag{8}$$

where

$$E_{\max.} = \frac{m\omega_0^2}{ek} \tag{9}$$

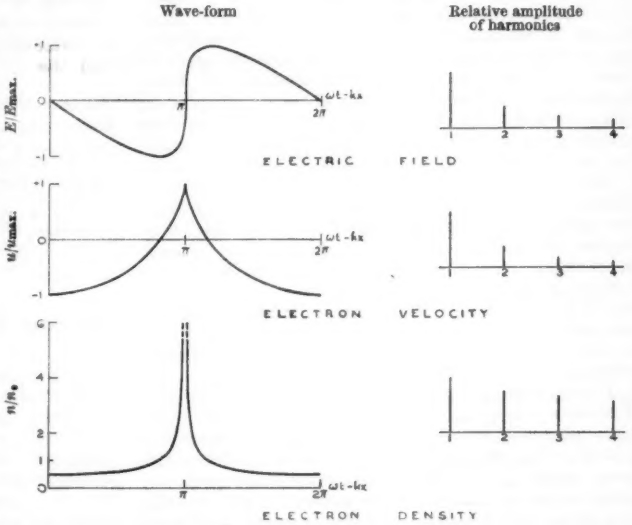

Fig. 1. Longitudinal plasma oscillations. The maximum electron velocity equals the phase velocity

The oscillations reach their greatest amplitude where $u_{\max.} = \omega_0/k$, that is, where the maximum electron velocity, $v_{\max.}$, equals the phase velocity, ω/k. The wave-form and harmonic content of the oscillations for this case are illustrated in Fig. 1. As can be seen, the oscillations contain even and odd harmonics, with about 70 per cent second harmonic in the case of the electron density. Below maximum amplitude the harmonic content is weaker and approaches the linear case (fundamental only) for small amplitudes.

If large oscillations of this kind are responsible for the emission of solar radio bursts, the present results would suggest that harmonics higher than the second may yet be discovered.

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Disintegration Scheme of Copper-62 and its Relation to Recent Mass Measurements

Several nuclear data tables[1,2] report the existence of a 0·56-MeV. γ-ray in the disintegration scheme of the positron-emitting isotope copper-62, the evidence advanced being an unpublished absorption measurement. We have lately had occasion to examine the spectrum of γ-rays emitted by copper-62, and have failed to find any evidence to confirm the existence of such a γ-ray.

A sheet of copper 3 in. × 4 in. × ¼ in. was irradiated with X-rays from a 23-MeV. synchrotron. Copper-62 was produced by (γ,*n*) reactions. This source was then placed 2 cm. from the end of a large cylindrical sodium iodide crystal 1¾ in. in diameter and 2 in. long, which was mounted on a DuMont type 6292 photomultiplier. This crystal was large enough for secondary quanta from Compton collisions and photoelectric absorption processes occurring in its interior to have an appreciable probability of being themselves absorbed. A copper absorber ⅛ in. thick was placed in front of the source to prevent positrons reaching the crystal. The output pulses were amplified and fed into a 100-channel amplitude analyser.

The resulting spectrum showed a single well-defined 'total capture' peak and Compton edge from the annihilation quanta superposed on the usual crystal background. The width of the peak at half-height was 14 per cent, that is, 0·066 MeV. No other peaks were observed in the channels corresponding to 0·6–1·2 MeV. We estimate, having regard to the background, that a peak containing 0·25 per cent of the counts in the total capture peak and of comparable width would have been detected.

The simultaneous absorption by the crystal of a 0·56-MeV. γ-ray and an annihilation quantum would have produced a 'coincidence' peak in the vicinity of 1 MeV. From the above upper limit to the detectable peak, and from the efficiency of crystal detection and solid angle subtended at the source, it follows that not more than 5 per cent of the positrons can be in coincidence with a 0·56-MeV. γ-ray.

Further, the absence of a peak in the observed spectrum in the range 0·6–1·2 MeV. means that there is no evidence for a γ-ray in the range 0·1–1·2 MeV., since γ-rays in the range 0·1–0·7 MeV. would have produced a 'coincidence' peak between 0·6 and 1·2 MeV., while γ-rays of energy between 0·6 and 1·2 MeV. would have produced the usual total-capture peak in the range 0·6–1·2 MeV. The upper limit of intensity allowed by our observations for a γ-ray in coincidence with the positrons is 5 per cent of the total number of disintegrations. No evidence exists that there is a γ-ray of energy greater than 1·2 MeV., and we conclude that there is no γ-ray in coincidence with the positrons. The total release of energy in the copper-62 disintegration can therefore be obtained from the maximum energy of the positron spectrum[3,4] and is 3·88 ± 0·1 MeV.

The spectrum of copper-62 is important for two reasons. First, the production of this isotope by (γ,*n*) reactions is very commonly used in the monitoring of X-ray beams in the energy range 10–30 MeV. Absolute monitoring is best done by irradiating a thick specimen and detecting the annihilation quanta. The estimation of the activity requires a knowledge of whether or not there are γ-rays emitted.

Secondly, the value of the total energy released calculated above throws doubt on the accuracy claimed for some recent mass measurements. Using the mean of two accurately measured values of the $^{63}Cu(\gamma,n)$ threshold[5,6], namely, 10·67 MeV., we find that the $(^{62}Ni + {}^{1}H) - {}^{63}Cu$ mass difference is 6·43 ± 0·12 m.m.u. This is significantly different from the value of 5·7 ± 0·1 m.m.u. obtained from the mass spectrometer measurements by Collins *et al.*[7] of the doublets $^{62}Ni - C_5H_2$ and $^{63}Cu - C_5H_3$. In the same region of the Periodic Table, the $^{64}Zn - {}^{64}Ni$ doublet shows a similar discrepancy, the value obtained from the decay scheme of ^{64}Cu [2] being 1·18 ± 0·03 m.m.u. and that obtained by Collins *et al.* being 2·01 ± 0·08 m.m.u. In view of the second discrepancy, it is not justifiable to attempt to explain the first discrepancy on some basis such as the (γ,*n*) cross-section of copper-63 being negligible in an energy region immediately above the neutron-binding energy. Until these discrepancies are explained, it would appear that the mass measurements in this region should be used with caution.

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Thermal Diffusion Potentials and the Soret Effect

In a recent communication[1], Tyrrell and Colledge have directed attention to the possibility of studying the Soret effect in solutions of electrolytes by observations of the e.m.f. of non-isothermal cells. In such cells, two reversible electrodes are maintained at different temperatures; owing to thermal diffusion, the concentration of solute around one electrode increases and that around the other decreases. In consequence, an additional e.m.f. should gradually be set up, which, for small temperature differences, is simply the e.m.f. of an isothermal concentration cell (with transport) operating at the mean temperature.

During the past two years, we have succeeded in demonstrating and measuring such changes of e.m.f. in various aqueous solutions, using the following electrodes, all of which give very reproducible potentials: platinum/tri-iodide, iodide; cadmium amalgam/cadmium ion; thallium amalgam/thallous ion. In our experiments, the temperature gradient has been established in sintered glass diaphragms, which prevent convection but may possibly give anomalous results in very dilute solutions owing to surface effects. Most of our observations have therefore been made at concentrations of 0·1 molal and upwards, it being known[2] that the presence of a sintered diaphragm does not affect the isothermal diffusion coefficients of 1–1 electrolytes in this concentration-range.

Experiments using the platinum/tri-iodide, iodide electrode in lithium iodide, potassium iodide and hydrogen iodide were carried out in a modified diaphragm diffusion cell, fitted with magnetic stirrers[2] and with water jackets, whereby the upper and lower compartments could be maintained at different temperatures. Clear evidence of the expected effect was obtained; but the method was found unsuitable for quantitative work because it was not possible to

maintain sufficiently isothermal conditions within each separate compartment even with vigorous stirring. For this reason a different technique, applicable to amalgam electrodes, was developed. The cell used is shown in Fig. 1; the solution is entirely contained in the sintered glass diaphragm, and since its thickness is only about 0·15 cm., Soret equilibrium is established rapidly. Owing to the comparatively poor thermal conductivity of mercury, there are appreciable temperature differences between the thermocouples and the electrode/solution interfaces, of which the temperatures are required. It is therefore necessary to calibrate the temperature-measuring system by comparing the initial e.m.f. of this cell (that is, the e.m.f. when the solution is homogeneous) with the e.m.f. obtained using similar electrodes in a homogeneous solution in a different apparatus in which the temperature gradients in the amalgams are negligible.

Fig. 2 shows some results obtained with thallium amalgam electrodes (5·0 per cent thallium by weight) in solutions containing thallous salts. A constant temperature difference of about 6 deg. C. was maintained between the electrodes from zero time onwards, the mean temperature being 25° C.; the observed e.m.f.'s are converted to the 'thermo-electric power' (ε) in mV. per deg., with the sign convention that positive ε implies a flow of current from hot to cold in the external (metallic) circuit when the cell is short-circuited. The expected changes of e.m.f. are clearly apparent. Magnetic stirring of the upper amalgam did not produce any detectable change in the e.m.f., showing that the observed effects are not due to thermal diffusion in the amalgam.

It has been shown theoretically[2] that, provided ionic interaction can be neglected, the final values of the e.m.f.'s of such cells should depend only on the nature and concentration of the ion to which the electrode is reversible, unlike the initial values, which depend also on the properties of the other ions present. It will be seen that this prediction is confirmed by the results; except in the case of thallous carbonate, the agreement of the final e.m.f.'s is surprisingly good in view of the comparatively high concentration used.

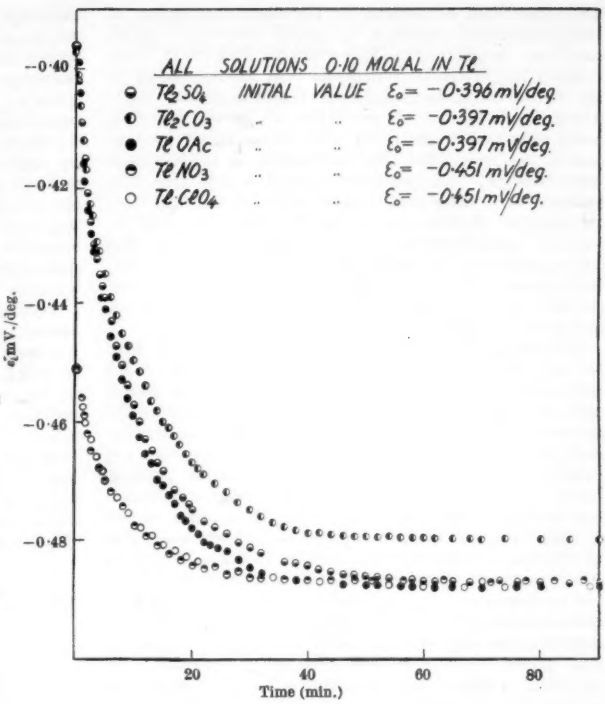

Fig. 2

The dependence of e.m.f. on time for these solutions agrees well with the theoretical relationship, although the simplified approximate expression given by de Groot[4] does not adequately represent the observations. A more complicated dependence on time is involved if a mixture of two electrolytes (for example, 0·1 *m* thallous perchlorate + 0·1 *m* perchloric acid) is employed. In this particular case the e.m.f. actually passes through a maximum; the initial value (ε_0 = − 0·662 mV./deg.) is very low owing to the exceptionally large Soret coefficient of the hydrogen ion; but the final value (ε_∞ = −0·478 mV./deg.) is close to that observed in other solutions containing thallium ion at concentration 0·1 *m*.

A fuller account of this work will appear elsewhere.

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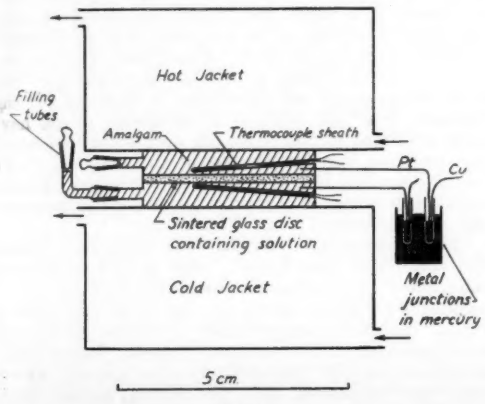

Fig. 1

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Fission of Peptide Bonds by Lithium Borohydride

The value of lithium aluminium hydride as a reagent for the characterization of the C-terminal residues of proteins has been investigated by several workers[1]; but, except in the case of insulin[2], the potentialities of lithium borohydride have been less fully explored. Grassmann, Hörmann and Endres[3]

have described a method for the characterization of the C-terminal residues of small peptides which involved esterification followed by reduction with lithium borohydride hydrolysis and identification of the amino-alcohols produced. When a similar technique was applied to procollagen[4], amino-alcohols were obtained even from the un-esterified protein and it was concluded that carboxylic ester groupings were present. Experiments carried out in this laboratory and described below show, however, that cleavage of peptide bonds can be brought about by lithium borohydride, those bonds involving the carboxyl group of glycine or of alanine being particularly susceptible. At present, therefore, little confidence can be placed in lithium borohydride as an end-group reagent for large peptides or proteins.

The reduction of small molecules, such as di- and tri-peptides, proceeds satisfactorily at 0° C. or at room temperature in tetrahydrofuran solution; but esters of large peptides and proteins are not soluble in the solvent, and more vigorous conditions, that is, heating and stirring, are necessary to achieve complete reduction of the ester group; simultaneous peptide bond cleavage then occurs. Benzoylglycylalanine methyl ester was treated at 0° for 18 hr. and at the boiling point for 4 hr. with five molecular proportions of lithium borohydride in tetrahydrofuran solution. After removal of excess reagent and inorganic salts the products were hydrolysed and submitted to paper chromatography. The products from the cold reduction were glycine and alaninol, as was expected, but those from the hot reduction contained in addition a significant quantity of ethanolamine as judged by the intensity of the spots.

The action of lithium borohydride on lysozyme and on the mixture of peptides obtained from the fission of silk fibroin at serine residues[5] was examined quantitatively. At the outset of this investigation no method was available for the quantitative isolation and identification of amino-alcohols present in mixtures containing amino-acids and inorganic salts. This was achieved by conversion of the amino-alcohols obtained on hydrolysis of the reduction products to their 2 : 4-dinitrophenyl-derivatives followed by partition chromatography. Details of this method will be published later. Two different procedures utilizing 2 : 4-dinitrophenyl-derivatives have been published recently[3,6,7]. The formyl seryl peptides from silk fibroin[5] were esterified with diazomethane and attempts were made to reduce the terminal ester groups using a solution of lithium borohydride in tetrahydrofuran at room temperature. The reaction was carried out in a thick-walled cylindrical flask containing a number of glass beads which was rotated in a horizontal position to bring about crushing of the insoluble solid. Apart from a very small amount of serinol, the only amino-alcohols isolated were alaninol and ethanolamine; but the combined yield of these was less than that expected from consideration of previous analytical data[5] even with a reaction period of three days and a large excess of reagent. When the reaction was carried out at 70–75°, much more rapid reduction occurred, the theoretical yield of amino-alcohols being obtained in about 12 hr. A reaction period of 18 hr., however, gave considerably more than the theoretical quantity of amino-alcohols. The same amino-alcohols, alaninol and ethanolamine, were also obtained when the peptides were treated under these conditions with the reagent without previous esterification. The combined yield was equivalent to nearly half the C-terminal carboxyl groups present. Although the free carboxyl group of hippuric acid was reduced to a small extent under these vigorous conditions, reduction of the free carboxyl groups could not account for the large quantity of amino-alcohols obtained from the un-esterified peptides. It was clearly impossible to distinguish between true end-groups and those formed by fission of the peptide chain. When lysozyme was treated in a similar way with lithium borohydride, the yields of ethanolamine and alaninol obtained were together equivalent to more than 3 C-terminal residues per molecule of weight 14,700. Appreciable quantities of serinol, valinol, phenylalaninol and leucinol (or *iso*leucinol) were also produced.

Hydrogenolysis of the C–N linkage of amides by metallo-hydrides has been observed by several workers[8]; when structural features are favourable, splitting takes place at room temperature and aldehydes are generally obtained. The formation of carbinols is also known. Apart from the greater lability of the glycine and alanine residues it appears that the polypeptide chain is attacked in a more or less random fashion by the reagent: the FDNB technique of Sanger revealed that a number of different N-terminal residues were liberated when lysozyme was treated with lithium borohydride.

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Protein Synthesis in the Cell Nucleus

There is considerable evidence that the cytoplasm of the cell contains structures capable of carrying out protein synthesis[1], and it has been shown in one case[2] that formation of protein may be little affected by removal of the nucleus. These findings seem to exclude the appealing hypothesis that the nucleus is the source of the cell's proteins. It does not follow, however, that the nucleus is incapable of protein synthesis; and in fact there has been some evidence[3] that proteins may be formed in the nucleus. The results described below seem to demonstrate unequivocally the existence of protein synthetic mechanisms that are associated with the nucleus.

The experimental material was *Amoeba proteus*. The conditions were basal; that is, the cells were maintained in inorganic medium without food organisms for 24 hr. before the first observations and during the entire experiment. Amoebae were cut into nucleated and enucleated halves. Intact cells served as controls. Immediately after cutting, whole cells and nucleated and enucleated halves were placed in inorganic medium to which methionine-^{35}S

Table 1. Averaged Values of Uptake and Incorporation of Methionine-^{35}S at Various Times after Cutting Cells. (W = intact cells; N = nucleated halves; E = enucleated halves)

		Hours after cutting when incubated in methionine-^{35}S			
		0–3	24–27	48–51	72–75
Total amount taken up	W	2·83	2·53	3·41	3·35
	N	1·46	1·42	1·80	1·64
	E	0·60	0·47	0·20	0·20
	W/N	1·9	1·8	1·9	2·0
	N/E	2·4	3·0	9·0	8·2
Amount incorporated into material insoluble in trichloracetic acid	W	2·16	2·05	2·63	2·41
	N	1·11	1·04	1·31	1·23
	E	0·18	0·17	0·07	0·06
	W/N	1·9	2·0	2·0	1·9
	N/E	6·1	6·1	18·7	20·0
Percentage incorporated	W	76	81	77	72
	N	76	73	73	75
	E	30	36	35	30
	W/N	1·0	1·1	1·0	0·96
	N/E	2·5	2·0	2·1	2·5

had been added, and remained there for 3 hr. After external methionine had been washed away, the total amount of activity that had been taken up by each group was determined with a windowless Geiger counter. Samples of fifty to seventy-five cells were sufficient. In a similar manner, the methionine uptake was determined in cells transferred to the methionine solution at 24, 48 and 72 hr. after cutting and left for 3 hr. After the measurement of total uptake of methionine-^{35}S, the samples were extracted with 5 per cent trichloracetic acid, and the remaining activity determined. This is assumed to represent methionine-^{35}S that had been incorporated into protein. The term 'percentage incorporation' refers to the fraction of the methionine-^{35}S which had entered the cell and is incorporated into the material insoluble in trichloracetic acid. Since it is unlikely that net accumulation of protein could occur under these basal conditions, we are in effect measuring the re-utilization of existing proteins to make new proteins.

The averaged results of the experiments are given in Table 1. The point of greatest interest to the present discussion is that percentage incorporation in the enucleated half drops to a level lower than that in the nucleated half by a factor of 2·5 immediately after the cell is cut in half. We observe further that while enucleation leads to a progressive decline in the uptake of methionine by the cells, it has no appreciable effect on percentage incorporation for a period of three days. By considering only percentage incorporation, we can evaluate the terminal synthetic steps which put the methionine into protein without being confused by effects of the experimental treatments on the uptake or preliminary metabolism of the amino-acid. The latter are interesting in themselves and will be discussed elsewhere.

The immediate decline in percentage incorporation upon enucleation may be interpreted to mean that part of the protein synthetic mechanisms of the cells is localized in the nucleus. Alternatively, it could mean that this fraction of protein synthesis is intimately coupled with some mechanism that is localized in the nucleus. Protein synthesis associated with the nucleus under the basal conditions of the experiment is about 40 per cent of the total.

The results confirm at the same time the conclusion that the cytoplasm is capable of protein synthesis. The fact that percentage incorporation in the enucleated half does not change appreciably for three days suggests further that the cytoplasmic mechanisms operate independently of the nucleus, except possibly on an indirect, long-term basis. It will not be expected that the relative levels of the synthesis of protein associated with the nucleus and the independent synthesis associated with cytoplasm will be quantitatively the same under other conditions. We would predict that the contribution of the cytoplasm will be relatively greater when the cell is growing and increasing its absolute protein content.

Can we assign to the protein synthesis associated with the nucleus a role that will be relevant to the administrative function of the nucleus in the cell? Let us assume that the routine synthesis of proteins—enzyme formation, etc.—is carried out by the cytoplasm. The nucleus might be synthesizing those proteins that remain within its boundaries and function there. A second possibility follows from currently discussed views on the relation between the genetic system and protein synthesis. There is evidence that ribonucleic acid transmits genetic information from nucleus to cytoplasm and there governs the formation of proteins[4]. So far as is known, the ribonucleic acid of the basophilic material involved in protein synthesis is not free, but exists as ribonucleoprotein complexes[5]. If the genetic system is not producing ribonucleic acid, but ribonucleoprotein, then protein formation associated with the nucleus may represent the synthesis of the protein part of the machinery whereby the cytoplasm makes its structural, catalytic and storage proteins.

A fuller account of this work will appear in another publication. The investigation was supported by a grant from the American Cancer Society (recommended by the Committee on Growth, National Research Council) and by University of California cancer funds. We thank Prof. Harold Tarver for methionine-^{35}S prepared in his laboratory.

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A New Reagent for the Histochemical and Chemical Detection of Calcium

The dyestuff 'kernechtrot' or nuclear fast red obtainable from G. T. Gurr, Ltd. (batch 3569), or T. Gerrard, Ltd. (nuclear fast red standard), has been found to be a sensitive reagent for the detection of calcium. In all instances the histochemical localizations of calcium indicated by the dyestuff have been confirmed by micro-incineration and microchemical tests. Mr. G. T. Gurr informs me that the manufacturers say that the nuclear fast red described here is an anthraquinone dyestuff, and the reactions with calcium salts parallel the reactions of other anthraquinone derivatives observed during a detailed study of histochemical methods for calcium which will be published elsewhere.

The nomenclature of the dyestuffs, and related substances, to which the term 'kernechtrot' has been applied, is complicated and deceptive. The substance mentioned here should not be confused with others to which the name has been applied, that involve

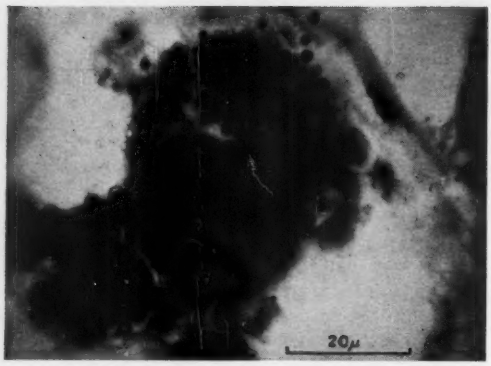

Fig. 1. Calcium cells of *Helix* digestive gland stained with calcium red reagent, showing intense coloration of individual spherules.

mixtures of dyestuff with a mordanting metal salt such as aluminium sulphate, or with the diazonium salts of somewhat similar names, for example, 'kernechtrot-salz B'[1]. I propose the name 'calcium red' for the standard dyestuff referred to here, which is itself, in the commercial samples tested by paper-partition chromatography, a mixture of components.

To use calcium red as a reagent for calcium it must be purified to some extent, which may be done by taking 2 gm. of the commercial dyestuff and washing it with 100 c.c. of distilled water twice. The residue is then made up into a saturated aqueous solution (about 0·25 gm. in 100 c.c.), and this solution will react rapidly with deposits of inorganic calcium salts, producing a lake in the form of a brilliant red precipitate. The reaction depends upon the liberation of free calcium ions, and hence is affected by the solubility of the calcium salt present. The reaction does not therefore take place with the intensely insoluble oxalate, found, for example, in the left colleterial gland of the cockroach[2].

Since the method depends upon the formation of a precipitate close to the site of the original substance, it is subject to the normal type of cytological diffusion error[3]. Nevertheless, localization is usually good. A full description of the procedure will be published elsewhere. The technique has worked with complete success upon the calcium deposits found in the following tissues: digestive gland of the snail (*Helix*), digestive gland of *Anodonta*, the hepatic cæca of *Carcinides*, the malpighian tubules of the cockroach, and the glands of Swammerdam of the frog. A clear distinction must be made between the formation of the dye-lake precipitate, and staining effects which may occur between the dye, the dye-lake, and the tissue proteins and other constituents, of the mordant-staining type, which cause a general pink staining of the background. This problem will be considered elsewhere.

The reagent may be used as a supra-vital reagent; also, as the laking response is not prevented by the presence of potassium hydroxide, provided the *p*H is not too high, it is likely that calcium red will be applicable in techniques for the gross staining of skeletal structures, in a manner comparable to alizarin red S.[4–6].

The reagent enables one to make an immediate distinction between tap water and distilled water. The dyestuff appears to show selectivity between the alkaline-earth metals, and aluminium and magnesium. The selectivity should be of importance in qualitative analysis, and it is hoped that this communication will bring the dyestuff to the attention of inorganic chemists.

I wish to thank Dr. J. R. Baker, Dr. W. G. B. Casselman and Dr. P. C. J. Brunet for their critical advice and encouragement. Mr. Edward Gurr and Mr. George Gurr have kindly provided me with information about the various 'kernechtrot' substances. I am grateful to Prof. A. C. Hardy for the excellent facilities of his Department. The work was carried out during the tenure of a Christopher Welch Scholarship, and a grant from the Department of Scientific and Industrial Research.

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An Intracellular Lipoidal Cycle and its Disruption by Neutral Red

A cytological study has been carried out on fixed, living and frozen-dried acinous cells of the pancreas of the mouse. Observations on fixed preparations prepared by Baker's[1] sudan black technique have shown that zymogen granules are formed from certain lipoidal prozymogen bodies which originate from mitochondria in the form of small granules. The granular prozymogen bodies migrate towards the Golgi apparatus and finally establish contact with it. It seems quite possible that the Golgi apparatus makes some contribution to the lipoidal bodies to be included in, or to facilitate, the production of zymogen. The prozymogen bodies next leave the Golgi apparatus and become vacuolated so that each one comes to consist of an outer lipoidal sheath which envelops an inner immature zymogen granule. In the zymogen zone the lipoidal sheath is lost and a mature zymogen granule makes its appearance, usually with a small particle of lipid adhering to its surface.

Zymogen secretion is brought about in a manner similar to zymogen synthesis. Among the zymogen granules a few small vacuolated bodies (1 μ in diameter) appear and increase in size at the expense of the surrounding granules. These bodies correspond with the secretion spaces[2] recorded by several workers and therefore are termed 'secretion bodies'. Each secretion body consists of an outer lipoidal coat and an inner substance which is formed by the absorption of the zymogen granules. The secretion bodies are usually extruded intact into intercellular secretion canaliculi along which they pass into the main duct system.

The sudan black method revealed no difference morphologically, apart from a slight difference in size, between vacuolated prozymogen bodies and small secretion bodies. Indeed, in some cells there was little doubt that some secretion bodies were formed by the coalescence of many small prozymogen

bodies. It appears, therefore, that zymogen synthesis and zymogen absorption are brought about by the activity of the same intracellular lipoidal cycle.

The intracellular lipoidal cycle is synchronized with, and part of, an intracellular secretion cycle. This secretion cycle consists of three main phases: (1) recovery phase, during which zymogen synthesis is maximal and there are many lipoidal prozymogen bodies; (2) resting phase, during which zymogen synthesis is minimal and there are few lipoidal prozymogen bodies; and (3) discharge phase, during which zymogen granules are absorbed by lipoidal secretion bodies.

When mice were each injected with 1 c.c. of a saturated solution of neutral red, the acinous cells eventually became filled with masses of neutral red granules. These originated from mitochondria in the same way as prozymogen bodies, and in fixed preparations coloured with sudan black. Morphologically they were identical with prozymogen bodies; but there was no evidence to suggest that they ever formed zymogen granules. Rather, the evidence supports the view that the cells had produced large numbers of lipoidal bodies which segregated the neutral red. Since there had been this great synthesis of lipid in the majority of cells irrespective of their physiological condition, it was clear that neutral red had disrupted the normal gearing of the intracellular lipoidal cycle with the secretion cycle.

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Lipid Nomenclature

The following views, although divergent in some particulars from those of Fisher[1], may be useful for consideration when the terminology of fatty substances is revised by an international commission, and in lipid chemistry generally.

It is desirable at the outset to define 'lipids' as the naturally occurring substances comprising fatty acids and their derivatives or compounds, and to subdivide them into homolipids, heterolipids and lipid complexes according to whether they contain only carbon, hydrogen and oxygen or these and other elements in addition, and according to whether they are true compounds or contain molecules associated by secondary valence.

In the accompanying scheme, based upon the recommendations of the International Union of Chemistry's Commission on the Nomenclature of Biological Chemistry[2], the proposed nomenclature for lipids is taken from the existing literature, supplemented in the case of the heterolipids with such modifications as are dictated by the necessity for transition from empirical to systematic chemical nomenclature when that is made possible by research.

(The spellings 'lipid' and 'lipide' are both in common use; 'lipid' is adopted here by analogy with other sciences[3] and because of the specific chemical significance of the suffix '-ide'[2]. The pronunciation 'lipid' is suggested by derivation from λιπος. The term 'lipoid', which was probably the most correct etymologically, has now fallen into disuse; '-ide' in

Proposed Classification of Lipids

1. Homolipids
   - *a.* Glycerides
   - *b.* Ester waxes: (i) Cerides (higher acyl esters of long-chain primary alcohols); (ii) Sterides (higher acyl esters of sterols)
   - *c.* Glyceryl ether esters (higher acyl esters of glyceryl long-chain alkyl ethers, for example, selachyl alcohol)
   - *d.* Etholides (alternatively estolides: lactide-like condensation products of hydroxy acids)
   - *e.* Lipoglycosides (higher acyl compounds of carbohydrates, etc.)
2. Heterolipids
   - *A.* Phospholipids
     - *a.* Phosphatides (heterolipids containing phosphorus and possibly, but not necessarily, amino-nitrogen; the latter can be indicated by prefix in reference to individual compounds):
       - (i) Phosphoglycerides (phosphatidyl ethanolamine, phosphatidyl choline, phosphatidyl serine, etc.)
       - (ii) Phosphoinositides
       - (iii) Phosphoglyceroinositides
       - (iv) Phosphoglyceracetals (acetal-phospholipids, formerly plasmalogens or acetal phosphatides)
       - (v) Polyphosphoglycerides (for example, cardiolipin).
     - *b.* Phospholipamides (heterolipids containing phosphorus and amido-nitrogen):
       - (i) Lipamidolphosphorylamines (containing fatty amide, long-chain alcohol, phosphoric acid and base; for example, sphingomyelin)
       - (ii) Lipamidolphosphates (fatty amide, alcohol and phosphoric acid; for example, ceramide phosphates)
   - *B.* Lipamides (heterolipids containing amido-nitrogen but no phosphorus)
     - *a.* Ceramides
     - *b.* Lipamidolglycosides (containing fatty amide, alcohol, carbohydrate and base; for example, cerebrosides)
   - *C.* Sulpholipids
3. Lipid Complexes (association by accessory valence)
   - *A.* Phospholipid-carbohydrate complexes
   - *B.* Lipoproteins

glyceride, phosphatide, etc., is justified by common use.)

The appellation 'ternary' is not true of cerides, etc., so listed in the International Union's classification, and the term 'complex' is more properly applied to association compounds[4].

'Phosphatide', as originally defined by Thudichum[5] to mean fatty substances containing phosphorus and possibly but not necessarily nitrogen, has been retained; but, as exemplified in the table, reference has been restricted to amino groups. The term is still the one most widely used for the substances thus listed[6,7], and Channon and Chibnall[8] explicitly derived from it the name 'phosphatidic acid', a less cumbersome alternative for di-acyl glycerophosphoric acid.

Afterwards, Folch[9] used phosphatidic acid as the basis for referring to the compounds formerly called lecithin and kephalin, as phosphatidyl choline and phosphatidyl ethanolamine, respectively. The analogous α-amino-hydroxypropionic acid derivative is designated 'phosphatidyl serine'.

Folch-Pi and Sperry[7] agreed to the retention of 'lecithin' for alcohol-soluble phospholipid fractions and 'kephalin' for the alcohol-insoluble; lecithin, thus defined, usually contains both phosphatidyl choline and ethanolamine.

The isolation by Folch[10] of phosphatides of which the characteristic polyhydroxy residue is inositol led that worker and Sperry[7] to propose the term 'phosphoglyceride' for the type of substance dealt with in the two preceding paragraphs. The extension of this nomenclature to 'phosphoglyceroinositides' for phosphatides containing both polyhydric residues[11] follows naturally. It should be noted that the term 'glycerophosphatide', proposed by Celmer and Carter[6], is redundant and phosphoglyceride is therefore preferable to it.

Although the acetal-phospholipids, formerly called plasmalogens or acetal-phosphatides[12], fall within the group defined as phosphatides, it is necessary to denote in their terminology the difference between the diacyl character of the phosphatidyl compounds and the acetal of the 'plasmalogens'. The general term 'phosphoglyceracetals' is therefore proposed for them, and individual compounds[13] can be distinguished by placing the name of the nitrogenous moiety before the class name.

The suggested introduction of 'phosphoglyceratid'[1] could lead to ambiguity as to whether the compound was of the glyceride or acetal type; moreover, it does not seem to offer any advantage over extant usage. 'Phosphoglycolatid' is excluded as referring to a synthetic product.

Regarding those heterolipids which are characterized primarily by the presence of nitrogen, it is fairly generally the case that at least one of the nitrogen atoms is present in amido linkage[14]. 'Lipamide' and 'phospholipamide' therefore seem to be obviously suitable as general terms for those compounds, and they make possible a subclassification of some of the compounds listed under 'sphingolipids' by Celmer and Carter[6].

Cerebrosides (to use the current term) would remain a subgroup of lipamides. In the selection of names for these subgroups, it should be borne in mind that it has recently been shown[15] that they may give rise on hydrolysis to amines other than sphingosine. The inclusion of names of specific compounds such as sphingosine as roots of general terms is therefore to be avoided.

Individual lipamides and phospholipamides can be specifically named, according to the proposed system, by substitution of the stem-names of the fatty acid, long-chain alcohol and base for the roots 'lip-', '-ol-' and 'amine', respectively, in the general term. Sphingomyelin (although now sufficiently well known by that name to remain as such) would be lignoceramidosphingosine–choline–phosphoric acid diester. Expansion of this for detail and transformation to the Geneva form, showing the compound as a substituted octadecene, present no difficulty.

The gangliosides, etc., remain for analogous treatment when their constitutions become fully known.

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Flowing Chromatography on a Circular Paper Pack

The possibility of combining the advantages of circular paper chromatography with those obtained by using an automatic fraction collector for separation and isolation of substances from a mixture has been investigated. The essential features of the technique consist in the application of the method of preparative circular paper chromatography[1] for the separation of the substances on a paper pack, followed by the elution of the components by means of a device for facilitating the flow of the solvent from the edge of the paper pack. Fig. 1 is a diagrammatic sketch of the apparatus devised.

The solution to be analysed is spotted at the centre of each Whatman No. 3 (31·5 cm. diam.) paper and the paper pack containing four or five papers is developed according to the procedure described before[1]. The paper pack is then subjected to elution. In this step, when the solvent front reaches the edge of the paper, the rate of flow will be prevented unless a special device is adopted to continue the flow. By serrating the edge of the paper pack as shown in Fig. 1, the slowing up of the solvent speed is prevented, thereby facilitating the regular flow through the pointed ends of each of the serrated edges touching the inner surface of the funnel (*E*).

The apparatus consists of two circular glass disks (*A* and *B*) (7–8 mm. thickness, 28 cm. diameter). At the centre of one (*A*) of the disks is cut a round hole of 3·2 cm. diam. The paper pack (*C*) after preliminary development has a hole cut at the centre with a diameter of 3·2 cm. and is placed between the glass disks, clamped by means of screw clamps (*D*).

Fig. 1

The paper pack with the glass disks is placed over a large funnel (*E*) (31·0 cm. diameter at the top), the pointed edges of the papers touching the inner surface of the funnel. A Petri dish (*F*) containing the solvent is placed over a glass triangular support inside the large funnel to saturate the atmosphere with the vapours of the solvent. The paper pack is then eluted with the solvent. The elution step is facilitated by the experimental arrangement shown in Fig. 1. It consists of a separating funnel (*G*) (100 c.c.) with a ground-glass joint, and another flask (*H*) (500 c.c.) which is first filled with elutant. The end of the separating funnel with the stopcock (*I*) closed is then inserted into the neck of the flask and inverted over the central hole, the neck of the funnel touching the surface of a small paper disk placed at the centre of the bottom disk. By opening the stopcock (*I*) the central well is filled with the solvent. By carefully manipulating the stopcock, the paper pack can be irrigated at a slow rate until the solvent front reaches the pointed edges of the paper. Later, the funnel (*G*) is completely filled with the solvent, and is carefully raised until the surface of the neck of the funnel is just above the surface of the bottom disk, so as to maintain a pool of solvent at the centre. A plastic ring (*J*) is placed over the solvent pool to minimize evaporation of the solvent. The stopcock is kept open until the solvent is completely drawn out. By this automatic device, continuous flow of the solvent can be maintained. The effluent coming out of the funnel (*E*) can be collected in a large number of fractions by means of an automatic fraction collector (*K*) and the fractions can be analysed according to the usual methods.

The method was applied to the separation of components from an artificial mixture of sugars and dyes. Mixtures of rhamnose (160 mgm.) and maltose (160 mgm.) (using *n*-butanol – ethanol – water), and rhamnose (200 mgm.), glucose (200 mgm.) and maltose (200 mgm.) (using butanol – acetic acid – water) were separated into fractions containing chromatographically pure components; the separation, however, was not quantitative, as some fractions contained mixtures of two sugars. A mixture containing methyl orange, neutral red and methylene blue was separated into individual components using 80 per cent ethanol as solvent.

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Relative Contribution of Disparity and Convergence to Stereoscopic Vision

Wright's[1] apparatus for measuring stereoscopic acuity has been modified to enable the measurements to be extended to wider separation between the tested targets. When operated in the dark, it provided two illuminated circular apertures seen against a black background. The experiments were carried out under two conditions of observation. Under condition *A*, the observer looked binocularly at one of the targets (*P*) and then to the second (*Q*). Under condition *B* the observer looked at *P* only but saw *Q* extrafoveally. In each case he was asked to estimate their relative apparent distances, and judge whether *Q* was nearer or farther than *P*.

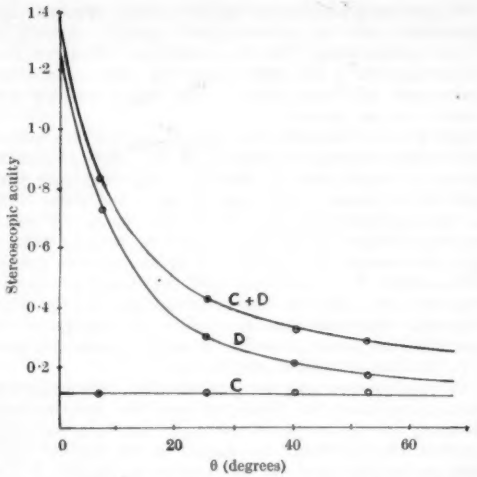

Fig. 1. Stereoscopic acuity decreases as the angle of separation (θ) between the two targets increases. *C* denotes convergence and *D* disparity

When the percentage estimates (for nearer, say) were plotted against the distance of the target *Q*, a typical psycho-physical ogive curve was obtained for each observer. From this the standard deviation was deduced as a measure for the threshold of stereoscopic vision.

Like other workers, and lately Wright, I find that acuity under condition *A* is greater than that under condition *B*, and in either case it decreases as the angle between the two targets increases. But there are conflicting views as to the explanation of the fact that stereoscopic acuity under condition *A* is higher than the corresponding value under condition *B*. The probable reason is that, under condition *A*, the convergence factor was operating, whereas under condition *B* it was absent. Since both convergence factor (*C*) and the disparity factor (*D*) co-operate in stereo-acuity, their percentage effects are considered to be simply additive.

From the experimental results, the ratio $(C+D)/D$ of the two effects can be found and so the effect of *C* alone can be isolated. Fig. 1 shows the change of either *C* or *D* with the change of the angle of separation. It shows that the role of convergence is relatively small (about 10 per cent of the stereo-acuity in the case of foveal vision), that disparity is the main factor responsible for stereoscopic vision, and that disparity does not fall below the corresponding value for convergence before an angle of separation of about 66°.

Convergence is found also to be of nearly constant value whatever may be the angle of separation. This proves that the process of convergence is nothing but a mechanical one, since the design of the eyeball enables it to rotate with great facility. Convergence is then a means of setting the eyes in the proper position for disparity to begin to act. The relatively small part played by convergence in stereoscopic vision agrees with the views of Wheatstone, Helmholtz, Valentine[2] and others.

Wright considered convergence to have a relatively important role in stereoscopic acuity, especially in the extrafovea. On the contrary, I believe his results lead to a negative value for convergence at zero angle of separation; this result cannot be understood at present.

Ogle's[3] view supports my opinion on the unimportance of the convergence factor. He assumes a fixation pause to occur between the two targets during the observation under condition *A*, and thus there will be optimal stereo-acuity when the point of convergence is half-way between these two targets. When I plot the results for condition *A* upon the same graph as condition *B* but at only half the angular separation, the two sets of observations are not greatly different. But this does not prove the adequacy of Ogle's assumption, since the fixation pause did not occur in the present experiments.

An explanation may be provided by Ogle's second assumption that the brain utilizes the information obtained during the rapid sweep of the eyes as they transfer fixation from one target to the other. The problem is still in need of further work.

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Sept. 20.

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[1] Wright, W. D., *Proc. Phys. Soc.*, B, **64**, 289 (1951).
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Functional Structure of the Retinal Fovea and Maxwell's Spot

A reddish spot can be seen in the centre of the visual field when a white surface is viewed by a normal observer through a dichroic filter transmitting red and blue lights. This phenomenon is called Maxwell's spot and interpreted usually as an entoptic phenomenon due to preferential absorption of blue light in macular pigment. Among various types, the commonest is of symmetrical circular form and is made up of three concentric zones: a spot, a clear ring and a halo, going from the centre to the outside[1,2]. The central spot and the halo are reddish, and the clear ring has the same chromatic quality as the background field, which is bluish-red in most cases.

Walls[2] has reported that protanopes and protanomals saw Maxwell's spot, whereas the majority of his deuteranopes and deuteranomals did not, and this has been confirmed by our experiment. The fact that, although deuteranopes have macular pigmentation, none of them can see Maxwell's spot makes the usual explanation of this phenomenon untenable. The central floor of the fovea contains little or no macular pigment[3], so that selective absorption of blue light is inconceivable, at least in the foveal centre. Nevertheless, the central part of Maxwell's spot looks reddish in the common type of normals. In view of these facts, Walls has presented a new hypothesis of non-uniform distribution of the receptor types in the fovea. This interpretation seems to receive support from the experiment by Motokawa *et al.*[4], indicating that the excitation of the blue receptor was decidedly small at the foveal centre compared with that of the red receptor.

In order to provide more conclusive evidence for the theory, we had our subjects plot Maxwell's spot with a dichroic filter, Wratten No. 2389, and explored the spatial distribution of retinal processes by means of Motokawa's method in the same subjects under comparable experimental conditions. This method has been described in detail in a previous paper[5], so that only its principle will be mentioned here. Following a brief illumination, the electrical sensitivity of the dark-adapted eye is measured, with electrical phosphenes as an index. The sensitivity increases above normal after a brief depression, reaches a maximum in a few seconds and decreases gradually to the resting level. Percentage increases in electrical sensitivity are denoted by ζ. ζ-values at 1, 2 and 3 sec. after termination of a photic stimulus represent the magnitudes of the red (*R*), the green (*G*) and the blue (*B*) processes, for the reasons stated in the previous paper[5]. As only red and blue lights were transmitted by the filter used, the processes *R* and *B* were measured at each retinal position. As is shown in Fig. 1, Maxwell's spot of a normal subject K. M. consisted of a spot, a narrow clear ring and a halo (type II of Walls's classification). Corresponding to the deep red spot at the foveal centre, *B* was definitely small compared with *R*, while both processes were of equal magnitude at the bluish-red clear ring. In the area corresponding to the halo, *B* was found to be greater than at the foveal centre, but still smaller than *R*. This distribution accounts satisfactorily for the quality of sensations at each part of Maxwell's spot. The regional variation of the *R* process cannot be explained in terms of the macular pigment, because red light eliciting *R* is not absorbed by the pigment.

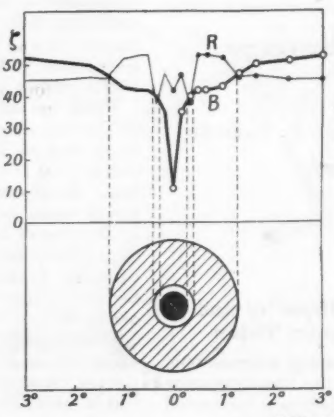

Fig. 1

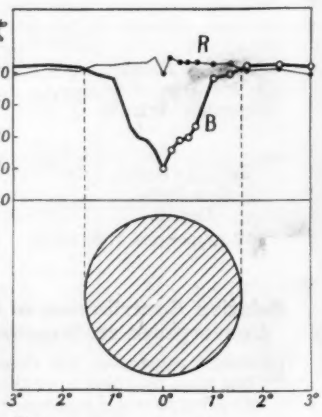

Fig. 2

Retinal position

Fig. 1. Spatial distribution of red (*R*) and blue (*B*) processes in fovea (above), and Maxwell's spot (below). Exploring spot of light was 2′ in visual angle during measurement of retinal processes. The more reddish-looking areas of Maxwell's spot are shaded with oblique lines

Fig. 2. Another case of normal Maxwell's spot and corresponding distribution of retinal processes

In Fig. 2 another normal type is illustrated (type IV). The structure of Maxwell's spot is much simpler in this case, in good agreement with the less complicated pattern of the distribution of *R* and *B*. In the foveæ of deuteranopes, *R* and *B* did not display any regional variation, as expected from the absence of Maxwell's spot.

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Grouped Variations in the Occurrence of New Protein Components in Normal Human Serum

A METHOD of zone electrophoresis using starch gel as the supporting medium has been developed. The advantages of zone electrophoresis and the convenience of protein detection by staining methods are combined with a resolving power in some cases superior to that obtained in free-solution boundary-electrophoresis. The method has been tested with human serum proteins, with cabbage enzyme preparations[1], and with crystalline β-lactoglobulin which has been successfully resolved into its two main components[2].

The present communication reports on variations in the number and distribution of the serum proteins from normal human individuals as demonstrated by this starch gel electrophoresis. A more detailed discussion of the present results and of the method, giving full experimental details, will be published elsewhere.

Sera free from visible hæmolysis products were prepared from forty-three normal individuals (twenty males, twenty-three females). In the preparation and electrophoresis of these sera the experimental procedures were carefully maintained constant.

A number of previously undescribed components was observed in all the serum samples, with a variation in the number of these observable in the serum from different individuals. However, all sera were found to fall into one of two main groups. Sera in the first group (I) gave a pattern of protein distribution of the type shown in the upper part of Fig. 1—the proteins being stained with amido-black 10*B*. This pattern resembles those obtained by conventional methods (except that several additional components present in small amounts can be seen), and the provisional identification of the main components was obtained by comparison with patterns obtained by the Tiselius and filter-paper electrophoretic methods. The second group (II) is characterized by the presence of three proteins (always absent in sera from group I) which migrate between the α_2- and β-globulins, and by the fact that the amount of protein-staining material migrating in the α_1 position is consistently much less in group II sera than in group I sera. Evidence suggesting that the additional material in the α_1 position in group I sera represents a distinct protein, or proteins, absent from group II sera, will be presented in the detailed publication.

The second group can be further divided into two subgroups (II_A and II_B). The distinction between the subgroups is that the αβ proteins present in group II_A sera migrate at a slightly faster rate than the αβ proteins in group II_B sera. Typical results obtained with sera from these two groups are presented in the lower two parts of Fig. 1. The difference between such sera has been certainly established for only a limited number of those concerned (by comparing sera from the two groups on the same gel). Confirmatory cross-checks on the remaining samples are being undertaken. However, on the basis of comparisons of the individual stained gels in which the αβ proteins can be seen, there is no reason for doubting the validity of the subdivision, nor was any difficulty experienced in assigning each serum to a definite group.

The number of sera in each group was found to be: group I, 10; Group II_A, 21; group II_B, 12.

No correlation appears to exist between the serum group and the blood group (*O*, *A*, *B*, *AB*, Rh^+ and Rh^-) of individuals, and there is no significant difference in the distribution of the serum groups for the two sexes ($\chi^2 = 3{\cdot}2$, $P = 0{\cdot}2$).

As judged by the present results on forty-three individuals, the groups are quite discrete; but the possibility remains that intermediate types might be encountered on extending the survey. A further possibility remains to be investigated more fully, namely, whether the serum group for a given individual is a permanent feature or is related to past infections. My own serum showed no change of group in six months, and that from several other individuals showed no group change over much shorter periods. If the constancy and discreteness of these serum

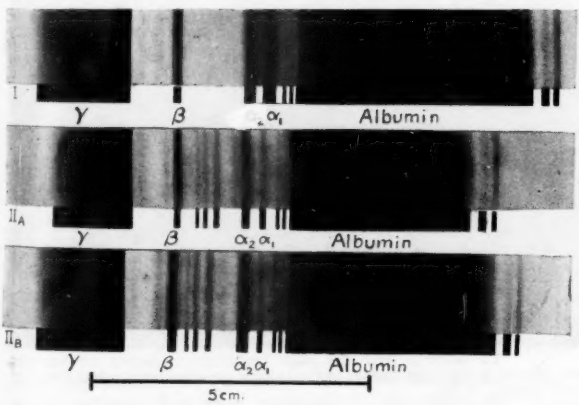

Fig. 1. Photographs and explanatory diagrams of the stained gels obtained with typical sera from (top to bottom) group I, group II_A and group II_B. Those components which show considerable variability even within a given group are not indicated in the diagrams. The differences in extent of migration of the front of the albumin in the three experiments should be disregarded; they will be considered in a later publication

groups can be confirmed, hereditary factors must be investigated.

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[1] Dixon, G. H., and Smithies, O. (unpublished results).
[2] Smithies, O. (unpublished results).

Long-Term Transplants of Infantile Rat Pituitaries cultivated *in vitro* and grafted in the Anterior Eye Chamber of Young Cats

During the past few years, we have made a number of attempts to obtain successful grafts between widely unrelated species of mammals. In most of these experiments the rat was used as the donor of the graft and the cat, an animal known for its refractoriness to foreign proteins, as receptor. The anterior eye chamber was chosen as the site of transplantation. In every experiment the anterior pituitary of 17-day old rats served as the graft, and kittens of between 21 and 60 days as graft receptors. In all, six cats with eighteen grafts were used as controls, and seventeen cats with eighty-three grafts as experimental animals. Early in the investigation it became evident that normal infantile rat pituitaries transplanted into the eye of the cat failed to survive for long periods. With one exception, where the grafted pituitary tissue was still present after thirty-five days, in twenty-four days the grafts were completely resorbed, although in every case vascular connexion with the host tissue was established.

If, however, the hypophysial tissue previous to transplantation was cultivated *in vitro* for fifty to sixty days at a temperature of 33–34° C. in a medium containing extract of young chicken embryos (seven to nine days old)[1] the transplants survived for much longer periods (Fig. 1). Even better results were obtained if the cultivated gland was first transplanted into the eye of the rat, then cultivated *in vitro* for a second time and finally grafted into the cat. The length of survival of these grafts has not yet been determined; but we have some which after three and four months of life in the host animal look quite healthy (Fig. 2). In an 86-day old double explant-graft of the type described above, numerous dividing chromophobes were observed (Fig. 3), and in a simple 59-day old explant-graft some dividing cells have also been found.

We must emphasize the fact that we are not dealing here with an all-or-nothing reaction. Some grafts, both of the normal and explanted tissue, live for longer and some for shorter periods; but on the whole, explant-grafts survive much longer than normal grafts. Some double explant-grafts, however, seem capable of indefinite survival.

At this stage it would be premature to speculate on the factors responsible for the prolonged survival of grafts cultivated *in vitro*. The impression is gained that more than one phenomenon is involved. It would, perhaps, be reasonable to assume that the chicken embryo extract exercises, in some still unknown way, a protective influence upon the grafted tissue, or in other words reduces the antigenic power of the graft. It is known that the anterior eye chamber presents an exceptionally favourable grafting site for many kinds of tissues. This may be partly due to the considerably lower temperature prevailing there in comparison with the body as a whole; it will be recalled that the incubating temperature *in vitro* was also subnormal (33–34° C.)[2]. Moreover, in the eye a large portion of the graft surface lies completely free, that is, not surrounded and compressed by other tissues. It is also possible that the type of biochemical reactions that take place in the eye of the host are not injurious to the transplant. We have noted one further phenomenon that may play a part in the success of grafting, namely, that after prolonged cultivation *in vitro* the gland becomes considerably tougher than the normal pituitary of comparable age.

In any event, some sort of non-specific adaptation seems to play the chief part in overcoming the humoral specificity of the host. This view is supported by the facts that survival of the graft is promoted by cultivation in the embryo extract of a species belonging to a different class of animals, and that explant-heterotransplants that for a time have lived in the eye of

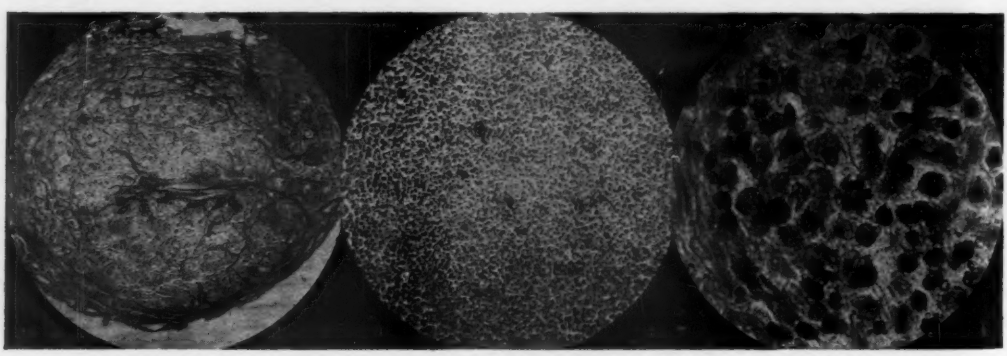

Fig. 1. Anterior pituitary of a 17-day old rat grown for 56 days *in vitro* and 59 days in the anterior eye chamber of a 30-day old kitten. × 80

Fig. 2. Anterior pituitary of a 17-day old rat; cultivated *in vitro*, then grown for 128 days in the anterior eye chamber of a hypophysectomized rat, again cultivated *in vitro* (10 days) and transplanted into the anterior eye chamber of a cat two months old, where it was maintained for 121 days. × 80

Fig. 3. A dividing chromophobe in the anterior pituitary explant-transplant of a 17-day old rat; cultivated *in vitro*, 128 days in the anterior eye chamber of a hypophysectomized rat, 10 days *in vitro* for a second time, and 86 days in the eye of a cat two months old. × 380

the rat lived so long when transplanted into the cat. Further work is in progress.

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[1] The technique of explantation of the pituitary gland has been described by Martinovitch: *J. Embry. Exp. Morph.*, **2**, 14 (1954).
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Paratyphoid-A Phage Typing

PHAGE-TYPING of typhoid and paratyphoid-B bacilli is now generally recognized as an indispensable aid in the control of typhoid and paratyphoid-B fever and is carried out in many countries according to internationally agreed standard methods[1]. On the other hand, the development of a useful typing procedure of *Salm. paratyphi A* has been long delayed.

In 1948, Felix and Banker made an attempt to evolve a typing scheme of *Salm. paratyphi A* similar to that which was first devised by Craigie and Yen[2] for the typing of *Salm. typhi*. The bacteriophage chosen for this purpose had been isolated in 1943 by the late Prof. R. G. Dhayagude from a sample of sewage in Bombay. The original phage (referred to below as Bombay phage or Type 1 phage), used in very high dilutions, lysed 83 out of 132 strains of *Salm. paratyphi A* isolated in distant parts of the world. The remaining 49 strains were all insusceptible. Only one adapted phage preparation was obtained in the course of the investigation of these insusceptible strains. The adaptation had occurred on a strain isolated in southern Palestine in 1925, and the epidemiological significance of the change thereby produced in the Bombay phage was demonstrated by the fact that cultures isolated from a patient who had acquired the infection in the same locality in 1947 were found to be fully susceptible to the adapted phage (Type 2) but were resistant to the original Bombay phage[3,4].

The original and the adapted phage were afterwards employed in the routine typing of cultures freshly isolated from cases of paratyphoid-A fever occurring in Bombay and in other parts of India; but all attempts at identifying further phage types of *Salm. paratyphi A* remained for a long time unsuccessful. At the Sixth International Congress for Microbiology (Rome, 1953) it was reported that no further progress had been made[5].

More recently, two further adaptations of the original Bombay phage were carried out, one to a strain isolated in India (received from the Haffkine Institute, Bombay), the other to a strain isolated in Egypt (received from Commander S. Barnes, U.S. Navy, Washington). This made it possible to subdivide *Salm. paratyphi A* into four different phage types which can be easily distinguished from one another (see Table 1).

The typing scheme outlined in Table 1 is very similar to those in general use for the typing of *Salm. typhi* and *Salm. paratyphi B*. The first place in the scheme has been assigned to the type of organism that is sensitive to the original phage and to all the adapted phage preparations derived from it. The remaining types are all characterized by their particular sensitiveness to the homologous adapted-type phage. However, on the basis of experience gained from the phage typing of *Salm. typhi* and *Salm. paratyphi B*, it may be predicted that future extension of the simple scheme presented in Table 1 will reveal the occurrence of cross-reactions between different phage types and will necessitate further subdivision into subtypes or varieties.

The original Bombay phage at first appeared to be strictly specific for strains of *Salm. paratyphi A* and was referred to by Felix[4] as a *Vi* phage acting on the specific *Vi* antigen of *Salm. paratyphi A*[6]. Afterwards it was found that both the original Bombay phage and the adapted Type 2 phage also lysed a number of strains of *Salm. gallinarum* and *Salm. pullorum*, organisms which do not contain the *AVi* antigen. The Bombay phage, therefore, is to be considered to be an *O* phage, and the conclusion is that the phenomenon of 'adaptability' is not restricted to *Vi* phages but is one of much wider application (Felix, personal communication). The fact that the Type 2, Type 3 and Type 4 phages listed in Table 1 are fully neutralized by antiserum to Type 1 phage confirms that all these phages represent genuine adaptations of the original Bombay phage.

Thanks to the help of Dr. A. Felix, joint chairman and secretary of the International Committee for Enteric Phage Typing, and of many workers in different parts of the world, it has been possible to examine within a short time paratyphoid-A strains isolated in countries in all five continents. It is of especial interest to note that out of more than five hundred strains examined with the four typing phages so far available, less than 10 per cent remained untypable. This seems to indicate that the total number of existing phage types of *Salm. paratyphi A* is not as great as that of *Salm. typhi*. It is known that in many parts of the world the proportion of untypable typhoid strains still continues to be greater than 10 per cent, although more than thirty different phage preparations are now being employed in the typing of this organism[5]. The most common phage type of the paratyphoid-A bacillus so far encountered is Type 1. It is too early to state what is the relative frequency of the other three types.

Paratyphoid-A infection is almost non-existent in Europe and America, but it is indigenous to many parts of Asia, especially India, Pakistan, Indo-China, Indonesia and other island groups of Oceania; it also occurs in Egypt and other countries of North Africa. Although not so prevalent as typhoid fever in many of these regions, the incidence of paratyphoid-A fever is sufficiently high to be rated as endemic. Dhayagude and Banker[7] estimated that only about 10 per cent of the enteric fever cases treated in Bombay hospitals during 1948–49 were due to *Salm. paratyphi A*, the remaining being caused by *Salm. typhi*. However, the true incidence of

Table 1. PROVISIONAL TYPING SCHEME OF *Salm. paratyphi A* ACCORDING TO FELIX AND BANKER

Type strains of *Salm. paratyphi A*		Bacteriophage preparations			
		Type 1	Type 2	Type 3	Type 4
		Test dilutions			
Type	Isolated	1/20,000	1/20,000	1/10,000	1/4,000
Type 1	Bombay	*CL*	*CL*	*CL*	*CL*
Type 2	Palestine	—	*CL*	—	—
Type 3	India	—	—	*CL*	—
Type 4	Egypt	—	—	—	*CL*

CL, confluent lysis with standard loopful of test dilution of phage.
—, no plaques

paratyphoid-A infection in India and in other endemic areas is not yet known and may well be much higher than that estimated for Bombay. There can be little doubt that the phage-typing method used as an epidemiological tool will prove to be an indispensable aid to the ultimate control of this infection.

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[1] Craigie, J., and Felix, A., *Lancet*, i, 823 (1947). Felix, A., and Callow, B. R., *Lancet*, ii, 10 (1951).
[2] Craigie, J., and Yen, C. H., *Canad. Pub. Health J.*, **29**, 448, 484 (1938).
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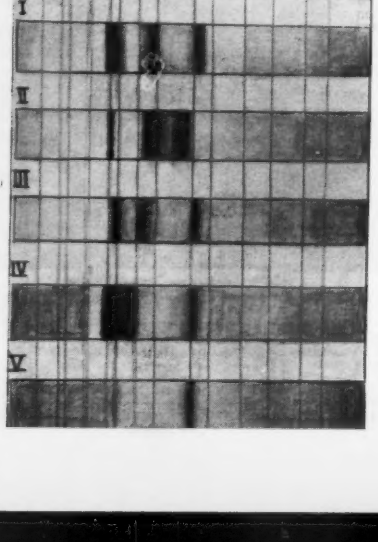
Nature of the Pigment of *Aplysia depilans*

By heating an aqueous solution of the actual excretion of the Mediterranean sea-slug *Aplysia depilans*, the violet pigment is separated from its protein part. The colour of the aqueous solution varies conformably with the *p*H, from blue (*p*H 1–2) to garnet red (*p*H 8–12·0).

The chloroform solutions of this pigment exhibit maxima at 6100, 5350, 4975 and 3800 A. (spectrum I), and they yield violet, red and green zones upon a column of powdered sugar. The violet pigment is absorbed in the top of the column, while the red is absorbed in the middle part, and the green pigment, travelling faster, at the end of the column.

Elution with chloroform–ethanol mixture (2: 1): the chromatographically separated violet pigment exhibits maxima at 5860, 5290, 4925 A., and its zinc complex salt at 6280, 5927, 5440 and 5040 A. (III). The red pigment shows maxima at 5910, 5315 and 5007 A. Its zinc complex salt shows maxima at 5950, 5500 and 5015 A. (II). The third greenish-blue pigment shows no absorption maxima in the visible range, but an extinction of colour in the violet and red regions of the spectrum. Unfortunately, because of its very low concentration, we could not distinguish absorption bands.



The ethanolic solutions of all three pigments separated show intensive red-brownish fluorescence. The chloroform solutions of the actual pigment, as well as the solutions of the three pigments separated, become dark blue when treated with a stream of dry hydrogen chloride. This blue chloroform-soluble pigment exhibits maxima at 5950, 5475 and 4927 A. (IV), and gives with zinc acetate a reddish-brown fluorescence with maximum at 5982, 5495 and 5055 A. and simultaneous extinction in the red and violet regions. After several hours, the blue pigment becomes greenish, and its spectrum shows an intense extinction in the red to 5583 A., with only a maximum at 4955 A. (V); its zinc complex salt exhibits maxima at 6255 and 4983 A.

The Gmelin reaction of these compounds is negative or very atypical. This fact, in combination with the red fluorescence, suggests that they are porphyrin in nature[1]. They do not behave like bilichromes[2].

Details of this work will be published in the *Bulletin of the Academy of Sciences, Athens*.

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[1] *C.R. Soc. Biol., Paris*, **92**, 1030 (1953). Fox, "Animal Biochromes and Structural Colours" (Cambridge Univ. Press, London, 1953).
[2] Lederer and Hutter, *Trans. Mem. Soc. Chim. Biol.*, 1055 (1942).

Peculiar Stratified Shape of Typhoon Waves

While M.V. *Tancred* of the Barber Line was riding out the typhoon of early October 1954 in Kobe Bay, we were able to observe a unique shape of typhoon wave which, so far as we know, has not been described. The vessel was hove-to with two anchors down facing the incoming gale (133 km./hr.) and the waves with crests up to 10 and 15 ft. were passing neatly along her side. From the rail we were struck by the peculiar appearance of the wave-slopes facing the wind.

On many of these there were a number of well-defined steps, carved so to say into the water just like the steps of a ladder, starting from the trough of the wave up to about half its height. Although the waves were moving quickly the steps remained steady, extending parallel to each other for one or two metres in length. There were at times as many as twenty of these nicely successive steps cut into the body of the wave. We tried to photograph them; but the very poor visibility and the fast motion of the waves resulted only in a blurred print.

Were these steps carved in the wave slopes by high harmonics of the period of the typhoon squalls? These higher harmonics have been registered by sensitive modern microbarographs, and they might have something to do with the quite peculiar screaming of the wind, often reported by seamen during the squalls of tropical storms. Strangely enough, this peculiar whistling has never been noticed in the squall line of extratropical storms.

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FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public)*

Monday, February 14

UNIVERSITY COLLEGE, LONDON (in the Physiology Theatre, Gower Street, London, W.C.1), at 4.45 p.m.—Dr. Esmond E. Snell (University of Texas): "The Relationship of Structure to Catalytic Activities of Vitamin B_6".*

BRITISH SOCIETY FOR THE HISTORY OF SCIENCE, PHILOSOPHY OF SCIENCE GROUP (in the Joint Staff Common Room, University College, Gower Street, London, W.C.1), at 5.30 p.m.—Prof. D. J. O'Connor: "Determinism and Predictability".

INSTITUTION OF ELECTRICAL ENGINEERS, EDUCATION DISCUSSION CIRCLE (at Savoy Place, London, W.C.2), at 6 p.m.—Discussion on "Teaching Faraday's Law of Electromagnetic Induction".

PHARMACEUTICAL SOCIETY OF GREAT BRITAIN (at 17 Bloomsbury Square, London, W.C.1), at 7.30 p.m.—Dr. K. R. Capper: "The British Pharmaceutical Codex 1954 and the National Formulary 1955".

Tuesday, February 15

INSTITUTE OF PHYSICS, ELECTRONICS GROUP (at 47 Belgrave Square, London, S.W.1), at 5.30 p.m.—Mr. R. W. Douglas: "Properties of New Semi-Conductor Materials".

INSTITUTION OF CIVIL ENGINEERS (at Great George Street, London, S.W.1), at 5.30 p.m.—Mr. Fred Tattersall, Mr. T. R. M. Wakeling and Mr. W. H. Ward: "Investigations into the Design of Pressure Tunnels in London Clay".

INSTITUTION OF ELECTRICAL ENGINEERS, MEASUREMENTS SECTION (at Savoy Place, London, W.C.2), at 5.30 p.m.—Mr. W. E. Harris: Informal lecture on "The Service Engineer at an Atomic Energy Establishment".

SOCIETY OF CHEMICAL INDUSTRY, AGRICULTURE GROUP (at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Mr. B. M. Church: "Recent Aspects of Fertilizer Practice"; Dr. G. W. Cooke: "Present Fertilizer Practice and Future Possibilities".

UNIVERSITY OF LONDON, BRITISH POSTGRADUATE MEDICAL FEDERATION (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 5.30 p.m.—Prof. J. N. Davidson: "Nucleoproteins in Cell Structure". (From a Series of Lectures on "The Scientific Basis of Medicine".)*

UNIVERSITY OF LONDON (in the Anatomy Theatre, University College, Gower Street, London, W.C.1), at 5.30 p.m.—Mr. W. K. Taylor: "A Mathematical Model of Neuronal Interaction".*

ROYAL AERONAUTICAL SOCIETY, GRADUATES' AND STUDENTS' SECTION (at 4 Hamilton Place, London, W.1), at 7.30 p.m.—Discussion—"Is Postgraduate Study Abroad Worthwhile?" Chairman: Sir Arnold Hall, F.R.S.

Wednesday, February 16

INSTITUTE OF METALS, METALLURGICAL ENGINEERING COMMITTEE (at the University, Edgbaston, Birmingham), at 10.30 a.m.—Informal discussion on "The Treatment of Swarfs, Sawings and Residues in the Non-Ferrous Metal Industries".

ROYAL METEOROLOGICAL SOCIETY (at 49 Cromwell Road, South Kensington, London, S.W.7), at 5 p.m.—Dr. E. B. Kraus: "Meteorology in a Large Water Engineering Project".*

ROYAL STATISTICAL SOCIETY (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 5.15 p.m.—Discussion on "The Teaching of Mathematical Statistics at University Level".

EUGENICS SOCIETY (at the Royal Society, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Mrs. Judith Hubback: "The Fertility of Educated Women".*

ROYAL MICROSCOPICAL SOCIETY (at Tavistock House South, Tavistock Square, London, W.C.1), at 5.30 p.m.—Dr. E. S. Horning: "Hormones in Relation to Cancer".

ROYAL INSTITUTE OF CHEMISTRY (in the Chemistry Lecture Theatre, King's College, Strand, London, W.C.2), at 6.30 p.m.—Prof. Sir E. C. Dodds, F.R.S.: "Some Recent Advances in Biochemistry".

SOCIETY OF CHEMICAL INDUSTRY, CORROSION GROUP (at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 6.30 p.m.—Discussion on "Corrosion Prevention in the Home".

Thursday, February 17

ROYAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Scientific Papers.

UNIVERSITY COLLEGE, LONDON (in the Physiology Theatre, Gower Street, London, W.C.1), at 4.45 p.m.—Dr. S. R. Elsden: "Respiratory Mechanisms in Bacteria".* (Further Lectures on February 24 and March 3.)

INSTITUTION OF MINING AND METALLURGY (at the Geological Society of London, Burlington House, Piccadilly, London, W.1), at 5 p.m.—Scientific Papers.

LINNEAN SOCIETY OF LONDON (at Burlington House, Piccadilly, London, W.1), at 5 p.m.—Prof. Irene Manton: "Flagella Structure Based on Observations with the Electron Microscope"; Dr. J. R. G. Bradfield: "Fibre Patterns in Animal Cilia and Flagella".

INSTITUTION OF ELECTRICAL ENGINEERS, UTILIZATION SECTION (at Savoy Place, London, W.C.2), at 5.30 p.m.—Mr. P. J. Bhatt: "An Introduction to the Study of Servo-Mechanisms"; Mr. E. J. Davies: "The Development of 50 c/s Traction in France"; Mr. G. Gascoigne: "Electricity Applied to Oil Production".

UNIVERSITY OF LONDON, BRITISH POSTGRADUATE MEDICAL FEDERATION (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 5.30 p.m.—Prof. J. H. Gaddum, F.R.S.: "The Effects of Alcohol".* (From a series of lectures on "The Scientific Basis of Medicine".)

SOCIETY OF CHEMICAL INDUSTRY, ROAD AND BUILDING MATERIALS GROUP (in the Lecture Hall of the Institution of Structural Engineers, 11 Upper Belgrave Street, London, S.W.1), at 6 p.m.—Dr. R. N. J. Saal (Amsterdam): "A Study on the Significance of the Bitumen Ductility Test".

ROYAL AERONAUTICAL SOCIETY (at 4 Hamilton Place, London, W.1), at 7 p.m.—Mr. H. L. Cox: "Problems Associated with Stress Concentration".

CHEMICAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 7.30 p.m.—Scientific Papers.

ROYAL SOCIETY OF TROPICAL MEDICINE AND HYGIENE (at Manson House, 26 Portland Place, London, W.1), at 7.30 p.m.—Colonel H. W. Mulligan: "Recent Investigations on Trypanosomiasis in British West Africa".

Friday, February 18

INSTITUTE OF NAVIGATION (at the Royal Geographical Society, 1 Kensington Gore, London, S.W.7), at 5 p.m.—Mr. H. C. Pritchard: "Automatic Dead Reckoning Instruments".

PHYSICAL SOCIETY, ACOUSTICS GROUP (at the Royal Festival Hall, South Bank, London, S.E.1), at 5 p.m.—Mr. Ralph Downes, Mr. C. T. L. Harrison and Dr. W. H. George: "Musical and Acoustical Aspects of the Festival Hall Organ".

UNIVERSITY OF LONDON (in the Physiology Theatre, University College, Gower Street, London, W.C.1), at 5.30 p.m.—Prof. F. Bergel: "Attempts at Chemotherapy of Malignant Diseases".*

SOCIETY OF CHEMICAL INDUSTRY, CHEMICAL ENGINEERING GROUP (joint meeting with the FINE CHEMICALS GROUP, at King's College, Strand, London, W.C.2), at 7 p.m.—Mr. W. C. Peck: "Some Applications of Chemical Engineering in the Fine Chemicals Industry"; Mr. A. S. D. Barrett: "Vacuum and Freezedrying".

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 9 p.m.—Dr. J. McG. Bruckshaw: "The Implications of Rock Magnetism".

Saturday, February 19

BIOCHEMICAL SOCIETY (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 11 a.m.—Symposium on "The Biochemistry of Vitamin B_{12}".

LONDON COUNTY COUNCIL (at the Horniman Museum, London Road, Forest Hill, London, S.E.23), at 3.30 p.m.—Mr. A. J. Arkell: "The Magical Statuettes of Ancient Egypt".*

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

BIOCHEMIST (preferably with an honours degree or equivalent qualification) IN THE CHEMICAL PATHOLOGY LABORATORY—Prof. Gray, Department of Chemical Pathology, King's College Hospital, Denmark Hill, London, S.E.5 (February 15).

LECTURER (with a degree or other high qualifications in pure or applied chemistry) IN TEXTILE CHEMISTRY AND DYEING—The Registrar, Nottingham and District Technical College, Shakespeare Street, Nottingham (February 15).

LECTURER (with a degree or other recognized qualification in geology, together with some practical experience) IN GEOLOGY—The Registrar, Nottingham and District Technical College, Shakespeare Street, Nottingham (February 15).

ASSISTANT LECTURER (with a degree in engineering and/or agriculture with practical experience in farm implements and machinery) IN AGRICULTURAL ENGINEERING—The Secretary, North of Scotland College of Agriculture, 41½ Union Street, Aberdeen (February 16).

LECTURER IN BIOLOGY—The Principal, Borough Road College, Isleworth, Middlesex (February 21).

LECTURER IN APPLIED MATHEMATICS—The Registrar, King's College, Newcastle-upon-Tyne (February 28).

LECTURER OR ASSISTANT LECTURER IN THE DEPARTMENT OF BOTANY—The Secretary, Bedford College, Regent's Park, London, N.W.1 (February 28).

LECTURER (preferably with a university degree in physical chemistry or chemical engineering) IN CHEMICAL ENGINEERING—The Registrar, King's College, Newcastle-upon-Tyne (February 28).

ASSISTANT LECTURER (female) IN MATHEMATICS, and an ASSISTANT LECTURER IN PHYSICS—The Principal, Royal Holloway College, Englefield Green, Surrey (March 1).

CHAIR OF ANATOMY at the University of Sydney, Australia—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (Australia, March 1).

CRIPPS CHAIR OF PRODUCTION ENGINEERING—The Registrar, The University, Nottingham (March 1).

RESEARCH ASSISTANT (trained in physiology and/or biochemistry) IN THE DEPARTMENT OF ANÆSTHETICS—The Registrar, The University, Leeds 2 (March 1).

CHAIR OF PUBLIC HEALTH AND SOCIAL MEDICINE—The Secretary, The University, Edinburgh (March 8).

ASSISTANT STATISTICIAN (with a pass degree or equivalent qualification, and preferably with a knowledge of mathematics and horticulture (or botany)) for the examination and analysis of experimental data—The Secretary, East Malling Research Station, near Maidstone, Kent (March 15).

CHIEF LECTURER IN PHYSIOLOGY at the University of Queensland, Australia—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (Australia, March 15).

LECTURER or ASSISTANT LECTURER IN GEOGRAPHY at the University of Malaya, Singapore—The Secretary, Inter-University Council for Higher Education in the Colonies, 1 Gordon Square, London, W.C.1 (March 15).

CHAIR OF AGRICULTURE, at the School of Agriculture, Sutton Bonington—The Registrar, The University, Nottingham (March 16).

LECTURER, Grade 2 (with experience in either experimental or theoretical nuclear physics) IN THE DEPARTMENT OF PHYSICS, and an ASSISTANT LECTURER or LECTURER IN THE SUB-DEPARTMENT OF ACOUSTICS—The Registrar, The University, Liverpool (April 14).

LECTURER or ASSISTANT LECTURER (with a degree in pharmacy, or Fellow of the Pharmaceutical Society) IN PHARMACEUTICS, at the University of Malaya, Singapore—The Secretary, Inter-University Council for Higher Education in the Colonies, 1 Gordon Square, London, W.C.1 (April 15).

I.C.I. RESEARCH FELLOWS IN BIOCHEMISTRY, CHEMISTRY, CHEMOTHERAPY, ENGINEERING, METALLURGY, PHARMACOLOGY, PHYSICS or allied subjects—The Academic Registrar, University of London, Senate House, London, W.C.1 (April 16).

TURNER AND NEWALL RESEARCH FELLOWS IN ENGINEERING, INORGANIC CHEMISTRY, PHYSICS or an allied subject—The Academic Registrar, University of London, Senate House, London, W.C.1 (April 16).

ASSISTANT LECTURER (with good academic qualifications, and appropriate teaching and other experience) IN PHYSICS, at Flintshire Technical College—The Director of Education, County Education Offices, Mold, Flintshire.

CHEMISTS (Scientific Officer grade) IN THE BIOCHEMISTRY DEPARTMENT, to help in research on the formation of heterocyclic compounds in plants—The Secretary, Rothamsted Experimental Station, Harpenden, Herts.

EDITORIAL ASSISTANT (with a knowledge of chemistry)—The General Secretary, Society of Chemical Industry, 56 Victoria Street, London, S.W.1.

GENERAL EXPERIMENTAL PHYSICIST, Principal Scientific Officer or Senior Scientific Officer grade (with at least a first- or second-class honours degree in physics and several years general physical research experience), with the United Kingdom Atomic Energy Authority, Foulness, Essex, for the investigation of detonation phenomena—Senior Recruitment Officer, Atomic Weapons Research Establishment, Aldermaston, Berks, quoting 328/WGE/2.

HEAD (preferably with teaching, industrial and/or research experience) OF THE CHEMISTRY AND APPLIED CHEMISTRY DEPARTMENT—The Principal, Royal Technical College, Salford 5.

LABORATORY TECHNICIAN (fully trained in physiological techniques)—The Administrative Officer, Sir William Dunn School of Pathology, University of Oxford.

LECTURERS (with a degree or higher national certificate in electrical engineering or physics, and capable of training staff varying from operator to graduate) IN THE ENGINEERING TRAINING DEPARTMENT, Evesham—Engineering Establishment Officer, B.B.C., Broadcasting House, London, W.1, quoting EX.22N.

MATHEMATICIANS (with a first- or second-class honours degree in mathematics, and preferably with some research experience in an applied field) at various Ministry of Supply Research and Development Establishments in Southern England—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting A.28/5A.

PLANT PHYSIOLOGIST (with at least four years experience beyond the doctorate level in plant physiology, plant biochemistry or cytology (other than cytogenetics)) IN THE DIVISION OF APPLIED BIOLOGY, National Research Council, Ottawa, for fundamental research on problems of photosynthesis and related metabolism, translocation, tissue culture or cell physiology, to be carried on independently or in collaboration with others—The Director, Division of Applied Biology, National Research Council, Ottawa, Ontario, Canada.

PRINCIPAL (with high academic qualifications and appropriate educational and administrative experience) OF THE NORTHERN POLYTECHNIC—Clerk to the Governing Body, Northern Polytechnic, Holloway, London, N.7.

RESEARCH ASSISTANT (female), Assistant Experimental Officer or Scientific Officer grade, for duties which are concerned with research on serology of viruses—The Secretary, Foot-and-Mouth Disease Research Institute, Pirbright, Surrey.

RESEARCH FELLOW IN THE DEPARTMENT OF CHEMISTRY for work on the mechanisms of changes produced in polymers by radiations—The Secretary, The University, Edgbaston, Birmingham 15.

SENIOR LABORATORY ASSISTANT (with good industrial or other laboratory experience, and able to undertake the supervision of juniors) IN THE CHEMISTRY SECTION of the Department of Applied Science—The Principal, Wolverhampton and Staffordshire Technical College, Wulfruna Street, Wolverhampton.

SENIOR SCIENTIFIC OFFICER (with at least a second-class honours degree in metallurgy or equivalent, and with three years postgraduate research experience), at Sellafield, Cumberland, to undertake metallographic studies with particular reference to the behaviour of materials under irradiation and to welding of rare metals—United Kingdom Atomic Energy Authority, Industrial Group Headquarters, P.O. Box 19, Risley, Warrington, quoting 796.

TECHNICIAN IN THE BIOLOGICAL SECTION of the Department of Clinical Endocrinology, for duties which will include routine biological assays and assistance with biological research—The House Governor, Birmingham and Midland Hospital for Women, Showell Green Lane, Sparkhill, Birmingham 11.

REPORTS and other PUBLICATIONS

(not included in the Monthly Books Supplement)

Great Britain and Ireland

Department of Scientific and Industrial Research: Building Research Station. National Building Studies. Research Paper No. 24: A Study of the Interreflection of Daylight Using Model Rooms and Artificial Skies. By Dr. R. G. Hopkinson and J. Longmore. Pp. vi+24+1 plate. (London: H.M. Stationery Office, 1954.) 2s. net. [3011

Philosophical Transactions of the Royal Society of London. Series A: Mathematical and Physical Sciences. No. 927, Vol. 247 (30 November 1954): The Semi-Diurnal Tides Along the Equator in the Indian Ocean. By L. A. Fairbairn. Pp. 191–212. 7s. No. 928, Vol. 247 (30 November 1954): Homogeneous Dynamos and Terrestrial Magnetism. By Sir Edward Bullard and H. Gellman. Pp. 213–278. 2s. (London: Royal Society, 1954.) [3011

Colonial Office. Colonial Research 1953–1954. Reports of the Colonial Research Council; Colonial Products Council; Colonial Social Science Research Council; Colonial Medical Research Committee; Committee for Colonial Agricultural, Animal Health and Forestry Research; Colonial Insecticides Committee; Colonial Economic Research Committee; Tsetse Fly and Trypanosomiasis Research Committee; Colonial Fisheries Advisory Committee; Director—Anti-Locust Research Centre; and Research Matters not covered by the above Reports of the Specialist Advisory Bodies. Pp. 278. (Cmd. 9303.) (London: H.M. Stationery Office, 1954.) 7s. 6d. net. [3011

Department of Scientific and Industrial Research. Forest Products Research Special Report No. 8: The Dielectric Properties of Wood. By R. F. S. Hearmon and J. N. Burcham. Pp. iv+20. (London: H.M. Stationery Office, 1954.) 1s. 6d. net. [312

The Study of Prehistory—an Inaugural Lecture. By Prof. J. G. D. Clark. Pp. 35. (London: Cambridge University Press, 1954.) 2s. 6d. net. [312

British Engine Boiler and Electrical Insurance Co., Ltd. Technical Report—New Series, Vol. 2. Pp. 256. (Manchester: British Engine Boiler and Electrical Insurance Co., Ltd., 1954.) 12s. 6d. [312

Building Research Station Digest. No. 71 (November 1954): Frog Up or Frog Down. Pp. 3. (London: H.M. Stationery Office, 1954.) 3d. [312

Other Countries

Arbeitsgemeinschaft für Forschung des Landes Nordrhein-Westfalen. Heft 29: Das Problem der Residuen bei Lernvorgängen. Von Bernhard Rensch. Über Leberschäden bei der Bestimmung des biologischen Wertes verschiedner Eiweisse von Mikroorganismen. Von Hermann Fink. Pp. 86. (Köln und Opladen: Westdeutscher Verlag, 1954.) 6 D. marks. [3011

Canada: Department of Northern Affairs and National Resources. National Museum of Canada. Bulletin No. 132: Annual Report of the National Museum of Canada for the fiscal year 1952–53. Pp. iv+313 (18 plates). (Ottawa: Queen's Printer, 1954.) 1.50 dollars. [3011

Istituto Superiore della Poste e Telecomunicazioni—Roma. La VII Assemblea Plenaria del Comitato Consultivo Internazionale delle Radiocomunicazioni (C.C.I.R.), Londra, 1953. (Monografia No. 128.) Pp. 95. (Roma: Istituto Superiore della Posta e Telecomunicazioni, 1954.) [3011

Académie Royale de Belgique. Classe des Sciences Mémoires—Tome 28, Fasc. 6: Colloque Junius Massau tenu a Mond et Gand, les 26 et 27 Avril, 1952. Sous la présidence de M. J. Pérès. (Comité National de Méchanique théorique et appliquée.) Pp. 74. (Bruxelles: Académie Royale de Belgique, 1954.) 60 francs. [3011

Comision Nacional de Astronomia, Madrid. Publicacion No. 1: Resultado de la Observaciones del Paso de Mercurio por Delante del Disco Solar del 14 de Noviembre de 1953, Efectuadas en los Observatorios Espanoles. Por Jose M. Torroja. Pp. 29. (Madrid: Observatorio Astronomico, 1954.). [3011

Behringwerk-Mitteilungen—Heft 29. Hundertjahrfeier der Geburtstage von Paul Ehrlich und Emil von Behring in Frankfurt-Main, Marburg-Lahn und Hoechst: Verleihung der Emil von Behring-Preise 1948, 1952 und 1954. Zusammengestellt von Dr. A. v. Engelhardt. Pp. i+127+29 plates. (Marburg/Lahn: N.G. Elwert Universitäts- und Verlagsbuchhandlung, 1954.) [3011

Norsk Polarinstitutt. Skrifter No. 103: Studies on the Avifauna of Spitsbergen. By H. L. Løvenskiold. Pp. 131. 16 kronor. Meddelelser Nr. 77: De Gamble Trankokerier pa Vestspitzbergens Nordvesthjorne og den Formodede Senkning av Landet I ny Tid. Av. Rolf W. Freyling-Hanssen. Pp. 75–98. 2 kronor. (Oslo: A. W. Broggers Boktrykkeri A/S., 1954.) [3011

Anais da Academia Brasileira de Ciencias. Vol. 26, No. 1. Pp. ii+228+10 plates. (Rio de Janeiro: Academia Brasileira de Ciencias, 1954.) [3011

U.S. Department of the Army. Beach Erosion Board—Corps of Engineers. Technical Memorandum No. 41: Laboratory Study of Equilibrium Profiles of Beaches. By Ralph L. Rector. Pp. iv+38. Technical Bulletin No. 46: Field Investigation of Wave Energy Loss in Shallow Water Ocean Waves. By Charles L. Bretschneider. Pp. v+42. Technical Memorandum No. 50: Statistical Significance of Beach Sampling Methods. By W. C. Krumbein. Pp. iii+33. Technical Memorandum No. 51: Generation of Wind Waves over a Shallow Bottom. By Charles L. Bretschneider. Pp. iv+24. Technical Memorandum No. 53: Laboratory Study of Effect of Varying Wave Periods on Beach Profiles. By George M. Watts. Pp. iii+19. (Washington, D.C.: Beach Erosion Board, Corps of Engineers, 1954.) [3011

Astronomical Papers prepared for the use of the American Ephemeris and Nautical Almanac. Vol. 14: Solar Coordinates 1800–2000. By Paul Herget. Pp. xi+735. (Washington, D.C.: Government Printing Office, 1954.) 5 dollars. [3011

West African Institute for Oil Palm Research. Quarterly Progress Report No. 10 (July 1st, 1954 to September 30th, 1954). Pp. 16. (Benin City: West African Institute for Oil Palm Research, 1954.) [3011